DOCUMENT RESUME

ED 047 483	40	EC 031 917

AUTHOP Kohen-Raz, Reuven

TITLE Impairment and Training of Static Balance Ability in Educationally Handicapped Children. Final Report.

INSTITUTION Stanford Univ., Calif. School of Medicine.

SPONS AGENCY Office of Education (DHEW), Washington, D.C. Bureau of Research.

PUB DATE Sep 70

GRANT OEG-0-70-1263(607)

NOTE 129p.

EDRS PRICE EDRS Price MF-$0.65 HC-$6.58

DESCRIPTORS *Educationally Disadvantaged, *Exceptional Child Research, Learning Disabilities, Perceptual Development, *Perceptual Motor Learning, Reading Difficulty

IDENTIFIERS Balance Training

ABSTRACT

A sample of 247 Educationally Handicapped (EH) children at ages 6-10 was investigated to determine the role of static balance impairment in learning disabilities and the possibility of improving reading through balance training. Significant correlations between balance ability and reading level were found in only about 40% of the sample, indicating that learning difficulties of EH children may be categorized into balance related and balance unrelated. Three experimental subsamples were given a short term, structured, and programed balance training of equal duration (6 weeks), starting at different dates. One subgroup under the age of 9 and of average intelligence showed significant increase in reading ability after training when compared to controls matched for IQ, age, sex, father's occupation and balance ability. No experimental effects were apparent in the other two E-groups with higher age and lower intelligence. Nonreaders who also manifested low static balance ability did not improve in equilibrium control nor in reading in spite of intensified balance training of 12 weeks. Trainability in balance was significantly correlated with Performance IQ and reading level prior to the training. Length of stay in EH class correlated positively with reading in those experimentals whose reading improved after balance training. (Author)

FINAL REPORT

Project No.: OEG-0-70-1263 (607)

EC

IMPAIRMENT AND TRAINING OF STATIC BALANCE ABILITY IN EDUCATIONALLY HANDICAPPED CHILDREN

Reuven Kohen-Raz

Stanford University School of Medicine

September 1970

U.S. DEPARTMENT OF

HEALTH, EDUCATION, AND WELFARE

Office of Education

Bureau of Research

2

FINAL REPORT

Project No.: OEG-0-70-1263 (607)

IMPAIRMENT AND TRAINING OF STATIC BALANCE ABILITY IN EDUCATIONALLY HANDICAPPED CHILDREN

Reuven Kohen-Raz

Stanford University School of Medicine

September 1970

The research reported herein was performed pursuant to a grant from the Office of Education, U.S. Department of Health, Education and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent Office of Education position or policy.

U.S. DEPARTMENT OF

HEALTH, EDUCATION, AND WELFARE

Office of Education

Bureau of Research

CONTENTS

LIST OF TABLES

4

LIST OF FIGURES

ACKNOWLEDGEMENTS

We acknowledge the devoted collaboration of Mrs. Jean Nelson, Miss Cecely Bates and Mr. Marvin Moore who assisted in organising the study and carried out the balance training, as well as the efficient psychodiganostic work of Mrs. Zipporeth Kohen-Raz and of the team of testers, Miss Linda Thorne, Mrs. Barbara McGarr, Mrs. Ann Nichols, Mrs. Dianne Lucero, Mrs. Mike Seymour and Mrs. Linda Longstreth. Thanks are also due to Mr. Mark Stefik for elaborating the ataxiametric computer programs. This study could not have been carried ~~out~~ without the assistance of Dr. Bruce Keepis, Head of the Department of Research of the Palo Alto School District and Dr. Jim Massey, Head of the Special Education Services of San Mateo County as well as without the cooperation of the principals and teachers for the Educationally handicapped of the schools listed below, to whom we extend our sincerest thanks for putting their time and students at our disposal. We most appreciate the services of Mrs. Barbara Briggs and Mrs. Patricia Parkinson who volunteered to assist in the intensive training program.

Monte Vista, Eaton, Faria, Grant, Stocklemeyer, Doyle Schools in Cupertino.
Taft, Clifford, Ford Schools in Redwood City.
De Anza, Hollenbeck, Fairwood, Lakewood Schools in Sunnyvale.
Avalon, El Rancho Schools in South San Francisco.
Bowers, Montgomery, McCoy Schools in Santa Clara.
Hoover, Ross Road, El Carmelo, Palo Verde, Green Gables Schools in Palo Alto.
Nesbit School in Belmont.

ABSTRACT

A sample of 247 Educationally Handicapped children at ages 6-10, sampled from 7 School Districts, 26 schools and 39 classrooms on the San Francisco Mid-Peninsula was investigated as to the role of static balance impairment in learning disabilities and as to the possibility to improve reading through balance training. Using a method of electronic ataxiametry, significant correlations between balance ability and reading level were found in about 40% of the sample, whereas in the rest of the population this relationship was absent, indicating that learning difficulties of EH children may be categorized into balance related and balance unrelated. Three experimental subsamples were given a short term, structured and programmed balance training, the training being of equal duration (6 weeks) for each subgroup, but starting at different dates. One experimental subgroup composed of subjects under the age of 9 and of average intelligence showed significant increase in reading ability after the training when compared to controls matched for IQ, age, sex, father's occupation and balance ability. No experimental effects were apparent in the other two experimental groups with higher age and lower intelligence. Nonreaders who also manifested low static balance ability did not improve, neither in equilibrium control nor in reading, in spite of intensified balance training of 12 weeks. Trainability in balance turned out to be significantly correlated with Performance IQ and reading level prior to the training. Length of stay in EH class, while generally unrelated or negatively correlated to reading level and scholastic gains correlated positively with the latter variables during the experimental and post-experimental period in those experimentals, whose reading improved after balance training.

BACKGROUND OF STUDY

Static balance ability is essentially the capacity to maintain the typical human, upright posture under various (sometimes stressful) circumstances without any overt displacement of the feet and without any other part of the body (besides the feet) touching a supporting object or surface. This function must be differentiated from keeping equilibrium whilst in motion, as for instance, when walking on a rail or climbing a tree. Actually, factor analysis has repeatedly shown that "static" and dynamic" balance are represented by different factors of motor ability. (Fleishman, 1962). Thus, a child who seems to demonstrate good motor skill in riding a bicycle or in jumping over fences may still have difficulty to stand on one foot without moving.

The anatomical, physical, physiological and psychological aspects of the human body's static equilibrium have been extensively investigated by scientists from various disciplines, applying different methods and techniques. Medical research has tried to elucidate many neuro-physiological and physical factors involved in the act of standing, namely; muscle activity (Joseph, 1960; Mann &Inman, 1964); the location of the center of gravity and its displacements (Akerblom, 1948); the function of the vertebral column (Leger, 1959), the constellation of physical forces acting upon the ankle joint (Smith, 1957); the influence of sex and aging (Boman and Jalvisto, 1953); Hellebrandt & Braun, 1939); neurological correlates (Fearing, 1924); the mechanisms of the foot (Hicks, 1953, 1954); reflexological aspects (Hellebrandt, 1938); effects of temperature (Orma, 1957), etc.

Recently aerospace and naval medicine is giving increasing attention to problems of static balance (Graybiel and Fregly, 1966; Fregly & Graybiel, 1968). Relative to this wealth of investigations, medical research concentrating on developmental changes in the neurophysiological mechanisms of standing seems to be scarce, whilst the anatomical problems of postural habits in children have evoked considerable pediatric interest. (For an overview on this subject see Leger, 1959).

Psychological and educational research (and in the latter domain especially research in physical education), has been mainly concerned with strictly behavioral aspects of static equilibrium control. Some early publications on this subject date back to the beginning of the century (Hancock, 1894). Systematic data on the developmental patterns of static balance ability have been published by Oseretzki (1931) and by Sloan (1955). Norms for adolescents and young adults have been recently provided by Fleishman (1962) and for young children by Holbrock (1953), Kohen-Raz (1965), Stott (1968) and Keogh (1965, 1968). The main objective of psychological and educational research has been the establishment of developmental norms in order to predict physical performance and success of physical training. Recently systematic attempts have been made to investigate the impairment of balance in retarded and handicapped children. (Stott, 1968; Keogh and Oliver, in press).

In a recently completed study (Kohen-Raz in press) developmental patterns of static balance ability in normal children at ages 5 to 7 were assessed by using a technique of electronic ataxiametry described in detail below (page 36). The obtained scores for postures, none lasting more than twenty seconds, turned out to correlate significantly with teacher's evaluation of school readiness basic arithmetic skills and reading achievement. In the same study a sample of thirty three undifferentiated educationally handicapped pupils at age nine, having a generally but not significantly lower static balance ability in postures with occluded vision, was efficiently dichotomized by ataxiametric scores into balance impaired and balance unimpaired subjects.

OBJECTIVES AND DESIGN OF STUDY

In light of these latter findings it seemed to be worthwhile to investigate a representative population of Educationally Handicapped children focusing on two main issues:

1) The degree and frequency of weak balance control in Educationally Handicapped children and its relationship to the student's learning difficulties and clinical diagnosis.

2) The eventual impact of balance training on the scholastic progress of the Educationally Handicapped student, chiefly in the domain of reading, where correlations with equilibrium had been previously amply demonstrated in normal populations.

Whereas the first aim consists in adding a diagnostic measure and eventual diagnostic dimension to the large vague syndrom of the "Educationally Handicapped Child", the second objective is essentially the demonstration of an experimental effect, requiring the control of intervening variables in a population of extremely heterogenous character. The most pertinent of these variables besides age, sex, intelligence level and SES are the teacher and eventual "Hawthorne effects" produced by him, the nature of the disturbance of the child and finally the multitude of individual treatment methods (speech therapy, psychotherapy, remedial reading, etc.) offered to these children.

In view of all these intervening factors the training program had to be designed in a manner which would ensure an optimal control of contaminating variables, whilst their systematic elimination had to be

considered a priori as not feasible because of the very nature of the investigated population.

First, it was decided to sample only those children who were enrolled in EH classes.* Although this limited considerably the pool of eligible subjects, and thus required much wider sampling, it restricted the range of learning disabilities to the most difficult cases comparable at least by the external criterion of being unable to adjust to a normal class. Furthermore, the exposure to special teachers and treatment methods in the EH class is less variable than in the "learning center", as in the latter the child "commutes" between normal and special courses according to flexible and inconsistent schedules. The wide sampling implicitely lead to another partial control of intervening variables. As EH classes are small (8-10 students per classroom) and their number is restricted per school and district, many schools and classes had to be included in the sample which somewhat randomized such factors as the teacher, general and special remedial teaching methods, peer group influence, class atmosphere, etc.

Still, even with such general ways of controls through randomization an experimental design based on balanced cells of variables and exact

---

* Educationally Handicapped children either remain in a normal class and receive additional remedial treatment by special arrangements in so-called "learning centers", or else are transferred to "Special E. H. Classes", where they study in small groups separated from the normal school population and are given individual attention as well as intensive supplementary courses in various subjects.

matching was anticipated to be impracticable and therefore a longitudinal scheme of intensive retesting was designed, providing the possibility of additional longitudinal control. This was achieved by subdividing the experimental group into three subgroups, each to start its training at a different date, but for an equally long period (see below) and by re-testing Experimentals and Controls at the beginning and the end of each experimental sub-period.

This in turn implied that the training method had to be highly structured and its progress objectively scorable, so that each group would receive controllable and comparable amounts of training. It was assumed that by comparing longitudinal and cross sectional data in pairs matched for at least two or three major variables, the possible bias caused by additional unmatchable variables could be estimated and some insight be gained as to the eventual effects of balance training on scholastic achievements.

Taking into account the great mobility of EH students, as well as that of their teachers, the experimental intervention period had to be short, and because of the necessity to keep the three sub-periods equal, a span of the scholastic year had to be chosen which would not be interrupted by too long vacations. Thus the time between January 15 to June 1, divisible into three six weeks periods, was chosen as a period of intervention, using the part of the scholastic year preceding this period for gathering of diagnostic data and for preparing and pre-testing the training methods as will be detailed later.

SAMPLE

The sample was recruited from seven school districts, twenty-six schools and thirty-nine classrooms, as shown on Table 1 . Actually, it included all the available EH students within the age range 6 to 10, enrolled in EH classes on the San Francisco Mid-Peninsula from South San Francisco to Santa Clara. Thus more than representative this sample is comprehensive although its composition is difficult to define. The variety of clinical cases is considerable, but what seems to be more pertinent is a certain variability in selection procedures and selection criteria used by the special school services in the different school districts, as to which child should be placed in a EH class. Thus the different classes showed different "concentrations" of certain clinical types, so that for instance in some classrooms a majority of organic disturbances would be found whereas others included almost exclusively neurotic cases with no apparent neurological problems.

For the purpose of the training, three experimental groups had to be pooled from the total population and matched in pairs with appropriate controls. As preliminary data elaboration had shown that trainability in static balance is related to intelligence, as well as to age, it was decided to use the latter two as the main matching criteria adding to the latter static balance ability, and as far as possible, father's occupation.

This lead to a subdivision of the sample into eight categories (including not matchable experimentals and controls). As progress of non-readers could not be compared to that of these students who already had mastered reading, two further subcategories had to be added, namely non-reading experimentals and their respective controls, so that altogether ten subgroups were formed as shown on Table 2 .

TABLE 1

SAMPLE

School District	No of Schools	No of Classes	No of Subjects
Cupertino	7	11	92
Redwood City	3	6	31
Santa Clara	3	4	22
Sunnyvale	4	6	31
South San Francisco	2	3	15
Palo Alto	6	8	50
Belmont	1	1	6
TOTAL	26	39	247

TABLE 2

COMPOSITION OF SAMPLE AS PERSCHOOLS AND EH CLASSES

SCHOOL	CLASSROOM	EX I	CON I	EX II	CON II	EX III	CON III	EXNR	CONR	EXNOM	REM	TOTAL
I	047	1	3		1		1	1		1	4	12
	048	5			1					2	4	12
II	067		3		1						5	9
III	068		1									1
IV	077	3						1		2	1	7
	078	6	1								2	9
V	087		2			5	1	1		2		11
VI	097	3	1		4		1	1		1		11
	098	6									1	7
VII	107		3		2		1				5	11
	108				1						1	2
VIII	117			2	1		1					4
	118		2		1		1				3	7
	119						1			1	3	5
IX	127		1		1	4		1		1		8
	128				1			1				2
X	137					2				1	2	5
XI	167			9								9
	168			1					1	1		3
XII	177						3				3	6
XIII	187				3					1	4	8
	188		1				1					2
XIV	207				1						2	3
XV	217										2	2
	218				1				2		4	7
XVI	227		3		1					1	1	6
XVII	237							1	1	2	2	6
XVIII	257			3							1	4
	258			7						1	1	9
XIX	277				2						1	3
XX	287										6	6
XXI	307					5				5	1	11
	308		1		1		1				4	7
XXII	317			5						1	2	8
XXIII	327						1				2	3
XXIV	347		1								5	6
XXV	357				2				3		3	8
	358		1		2		2				1	6
XXVI	377						1					1
TOTAL		24	24	27	27	16	16	7	7	23	76	247

Because of geographical distances between schools and the nature of the intervention procedure, namely 20 to 30 minutes of training to be given individually three times per week to thirty-six subjects, whose presence in class is limited to three to four hours per day, (see below p. 32 experimental subjects could not be selected individually according to best fits into an experimental matrix unless using an excessive number of trainers. Therefore they had to be sampled in groups to be trained by one trainer traveling to one or at most two schools. This created a sampling bias as will be explained.

As already reported, different "concentrations" of certain types of disturbances were encountered in different schools. On the other hand, the objective of the intervention was to train static balance, and therefore the experimental groups had to be recruited from classes with at least 50% incidence of low static balance ability. Thus a higher representation of

certain types with balance impairment and concomitant lower reading ability was induced into the experimental groups. Controls, on the other hand, although matchable by age and intelligence with the experimentals, but because pooled from classes, with higher concentrations of better balancers and readers turned out to have a somewhat higher reading level. (Table 10 on page 48).

The general heterogeneity of I. Q. levels (ranging from 65 to 130) and of reading ability (ranging from Kindergarten level to third grade) precluded an eventual re-matching by reading level and intelligence.

The alternative, to match for reading level and losing control of I. Q. was contraindicated, as reading levels showed considerable and irregular changes even within the short period of our experiment and were certainly less reliable matching criteria than the I. Q. Besides a definitive relationship between trainability and I. Q. was discovered in the course of the study which made matching by I. Q. imperative. (See below,p.79).

As the design enables the observation of longitudinal patterns, the superiority of the controls in reading does not necessarily blur eventual training effects in the experimentals, as would happen if the direction of differences would be inverse (in such a case superior gains of the experimentals could be explained by their initial precocity and better preparedness to progress). A possible artifact to be watched in the case of controls being better readers are ceiling effects. These, however, can hardly be expected in the scholastically retarded EH children, besides that the very few subjects who approached the fourth grade level were given the Elementary Battery for grades four to six.

Table 3 shows the age and intelligence levels of the matched experimentals and controls in these groups. It will be noted that the three groups differ as to their age and intelligence level, Group II being the youngest and most intelligent. Table 4 presents the distribution of father's occupation and Table 5 the number of girls in each group which is very low as may be expected. The distribution of the intervening variables within the sub groups will be tabulated in the context of our findings in the subsequent sections of this report.

TABLE 3

AGE AND IQ IN EXPERIMENTAL AND CONTROL GROUPS

		EXP			CON		
	GROUP	N	M	SD	N	M	SD
IQ	I	24	92.9	11.3	24	91.3	10.5
	II	27	99.0	13.2	27	101.2	14.2
	III	16	95.6	9.8	16	96.7	9.2
AGE	I	24	8;10	12*	24	9;0	15
	II	27	8;3	7	27	8;2	8
	III	16	8;4	10	16	8;6	10

*SD in months

TABLE 4

FATHER'S OCCUPATION

N	24	24	27	27	16	16	7	7
	EX I	CON I	EX II	CON II	EX III	CON III	EXNR	CONR
Professional	9	3	7	7	2	3	0	1
White Collar	6	3	7	6	6	3	1	2
Blue Collar	3	7	3	7	3	5	5	2
Semi-Skilled	5	7	4	3	0	0	0	0
Not Classified	1	4	6	4	5	5	1	2

TABLE 5

DISTRIBUTION OF SEXES

	EX I	CON I	EX II	CON II	EX III	CON III	EXNR	CONR
Girls	2	2	4	4	3	3	2	2
Boys	22	22	23	23	13	13	5	5

PROCEDURE

The project started in midst October with the final budget approval one month after its designed starting date, but on the other hand, was tightly scheduled to a predetermined time table, chiefly because of the nature of the training program. The wide sampling required to contact a considerable number of school districts and schools, and for the sake of smooth cooperation great efforts were invested in establishing relationship with superintendents and teachers prior to the start of the field work. This was done chiefly through lectures and conferences given by the principal investigator at various places where the study was to be conducted. The time from midst October throughout November was thus dedicated to organize the sample and to record all the relevant background information on the two hundred forty subjects of the study on specially designed case history sheets (See Appendix I).

Parental consent to let their children participate in the study was obtained through the school districts, and only in four cases parents refused.

During the same period the training equipment was designed and constructed so that by December the elaboration and pretesting of the training program, as well as the training of the trainers could be carried out. Originally it was envisaged to pretest the tape recorded ataxiametric method and eventually to start to elaborate the ataxiametric computer program during that time. However, due to a six weeks delay in the delivery of the tape recorder, this could not be accomplished.

Immediately after Christma , the first mental tests were given, whilst the first Ataxiametric examinations did not start before midst January, for the above mentioned reasons. As no computer program was yet available, the ataximetric records were played into a polygraph and the visually inspectable data were used to estimate the balance impairment in the sample to be used in selecting experimental subjects. (See above p 11). As shown by the later computer analysis, these estimates were fairly correct as revealed by the good ataximetric match between Experimentals and Controls. (See below, p 90).

The mental examinations at each testing period were given by four to five different examiners, who tested different classes at different occasions. In addition, some of these testers, who had to be hired on a temporary basis for limited periods, left during the experimental period, and other ones took over. Although the assignment of testers to groups could not be systematically rotated during ten days throughout thirty classes, it was random enough (in addition to the already mentioned turnover) to prevent possible examiner bias. The personnel who tested the children had no information as to which children belonged to which experimental group and who remained in the pool of controls. The ataximetric examinations were carried out by the principal investigator and one technical assistant. They both travelled to the schools, carried and set up the portable equipment and tested each subject individually.

In organizing the experimental groups, the following criteria were used: Sampling of at least four different EH classes, representing

the whole range of age (6 to 9.6) and reading ability (non-readers to third grade level), and as already mentioned, including at least 50% bad balancers. In addition, geographical proximity between those two classes which had to be trained by one trainer during one morning, had to be taken into consideration.

As preliminary data elaboration had shown, a group of so called "low trainable" EH children emerged, characterized by low reading ability, slow scholastic progress and little improvement in balance ability as shown by the scores of their performance on the training apparatus (See below). Therefore, it was decided to dedicate the last third of the intervention period to so called "intensive training" and a greater number of prospective "low trainables" was included in the third experimental group which became manifest in their lower ataxiametric scores, lower reading scores and slow reading progress.

The time table of the three six weeks training periods was January 17 to February 28, March 1 to April 10 and April 13 to June 1, the last period including the Easter vacation.

Between the training periods, the whole sample was retested with the Metropolitan tests, so that altogether the results of four mental examinations were available. In this context however, a relative large absence rate in EH classes was encountered. This appears to be due to several possible factors: The greater sensitivity to disease in these children, and/or to a greater concern on the part of the parents not to send the child to school in case of minor ailments. In some cases parents seem not to care too much if the child wants to stay at home and finally

there was some mobility due to transfer, moving or discharge from the EH class. Although all efforts were made to test the whole population dispersed over thirty-nine classrooms within the ten days available for retest (a longer stretch of time would have lead to interference between the adjacent examinations spaced at only six weeks distance) and to have testers eventually return for a second time to test the absentees, gaps of test data were left, which by the fact of being randomly dispersed, limited the number of matchable pairs with four complete examinations and necessitated special procedures of data elaboration (See below).

In a similar way this caused an attrition of cases for whom ataxiametric and mental scores could be obtained, although the sample was sufficiently large to yield enough valid data.

The whole sample was retested with the ataxiameter, however due to a non-envisaged technical failure of the equipment, about 50% of the retest data, although reproducible on the polygraph necessitated a special way of retrieval by the computer.

The elaboration of the ataxiametric computer program, although initiated in spring, presented many problems and was not accomplished before June. This was mainly due to shortage of professional staff knowledgable to handle the tape recorded intake, and in particular the output of the signal box, specially constructed for this project.

Furthermore, the late arrival of the tape recorder at the beginning of the study, which severely limited the time for running in the equipment and eliminate its "bugs" (subjects had to be tested before the training

started) created some problems in the process of computorized retrieval of the tape recorded data which otherwise could have been avoided.

Towards the end of the study, preliminary experiments were carried out to record simultaneously EEG patterns and ataxiametric traces, using telemetric EEG equipment. At this stage no more than the feasibility of the technique could be demonstrated and only normal children were examined. A specimen of such a simultaneous record is given in Appendix III on page 125.

METHOD

Mental Testing

After consultation with the Research Department of Palo Alto Unified School District, it was decided to use the Metropolitan Tests* to measure the scholastic achievements of our subjects. The main reasons for this decision were the following: a) This test has not yet been used in California and would thus not be familiar to the subjects of our study, who have been repeatedly examined by a variety of instruments. b) The Metropolitan Readiness, Metropolitan Primary I and Primary II represent a sequence of grade levels which corresponds to the scope of scholastic achievements of our sample. c) According to previous experiences reported by the Palo Alto School District Department of Research, the test is sensitive to learning disabilities whereas other standard achievement tests failed to predict school failure within normally intelligent populations.

The Metropolitan is a group test, however, in the context of this study it was administered to small groups with maximal individual attention, and sometimes individually. Two examiners were assigned to five to eight children, in addition, the classroom teacher and her aid were present and actively assisted in the testing. Rest periods were interspersed in order to avoid fatigue and stress. Still, it occurred that children responded below their potential because of unrest, instability and lack of concentration, and in a very few cases, subjects refused to continue on certain items. These difficulties, which were anticipated, were recorded and whenever possible the child was then tested a second time when testers had to return anyway to examine those who had been absent.

---

* Published by Harcourt and Brace, New York.

A general overview of the first testing results revealed that about 30% had to be given the Metropolitan Readiness Test, i.e. were non-readers, 28% were on the first grade Primary I level and only 42% were able to score meaningfully on the Primary II.

In some cases, students had to be tested for a second time with forms of the adjacent higher or lower level, in order to assess optimally their level of achievement.

Some problems were encountered when examining those subjects who while still unable to read at the minimal level required for the Primary I, but were close to the ceiling of the Metropolitan Readiness Test. The following decisions were taken in these cases: a) For purpose of statistical comparison with pupils who respond to the Primary I or II, these students were considered to perform on grade level 1.0 b) When retested, attempts were made to give them the Primary I, even if their achievements were negligible. Those students who remained on the level of the Readiness Test throughout the intervention period were considered as "Non Readers" and were treated as a separate group (See above p 8).

Static Balance Training

Equipment

The training is performed on a specially designed piece of equipment which consists of a pair of rails, a pair of supporting handles and a feedback apparatus (See Figures 1,2). The rails can be shifted to various positions, as shown on Figure 1 . The handles can be adjusted to the child's height. The handles, as well as the supporting floor piece are sensitive to pressure resulting from stumbling, by virtue of tape-switches placed underneath the plates.

The feedback apparatus (Figure 2) consists essentially in a column of 16 colored bulbs which lighten from bottom to top and a music box playing a tune simultaneously whilst the child is keeping his balance. The time of the spectacle is 20 seconds. When the 16th light is reached, the counter registers 1 point. For more difficult items the experimental time is reduced to 10 seconds. Pushing the upper switch to the left will make the counter give credit after the 8th light. The right small box connects the apparatus to the balancing set (See Figure 1) which is provided with microswitches. When the child touches either the handles or the floor piece, the lights and tune will stop and inform the Examiner how many seconds the child was able to keep his equilibrium. The left small box is the remote control enabling the Examiner to reset and start the mechanism. The equipment is portable and is installed in a regular suitcase.

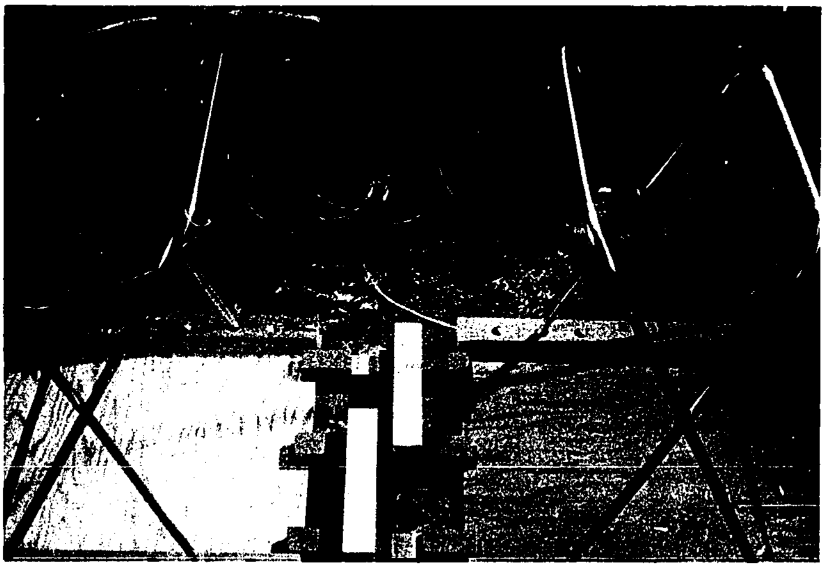


FIGURE 1

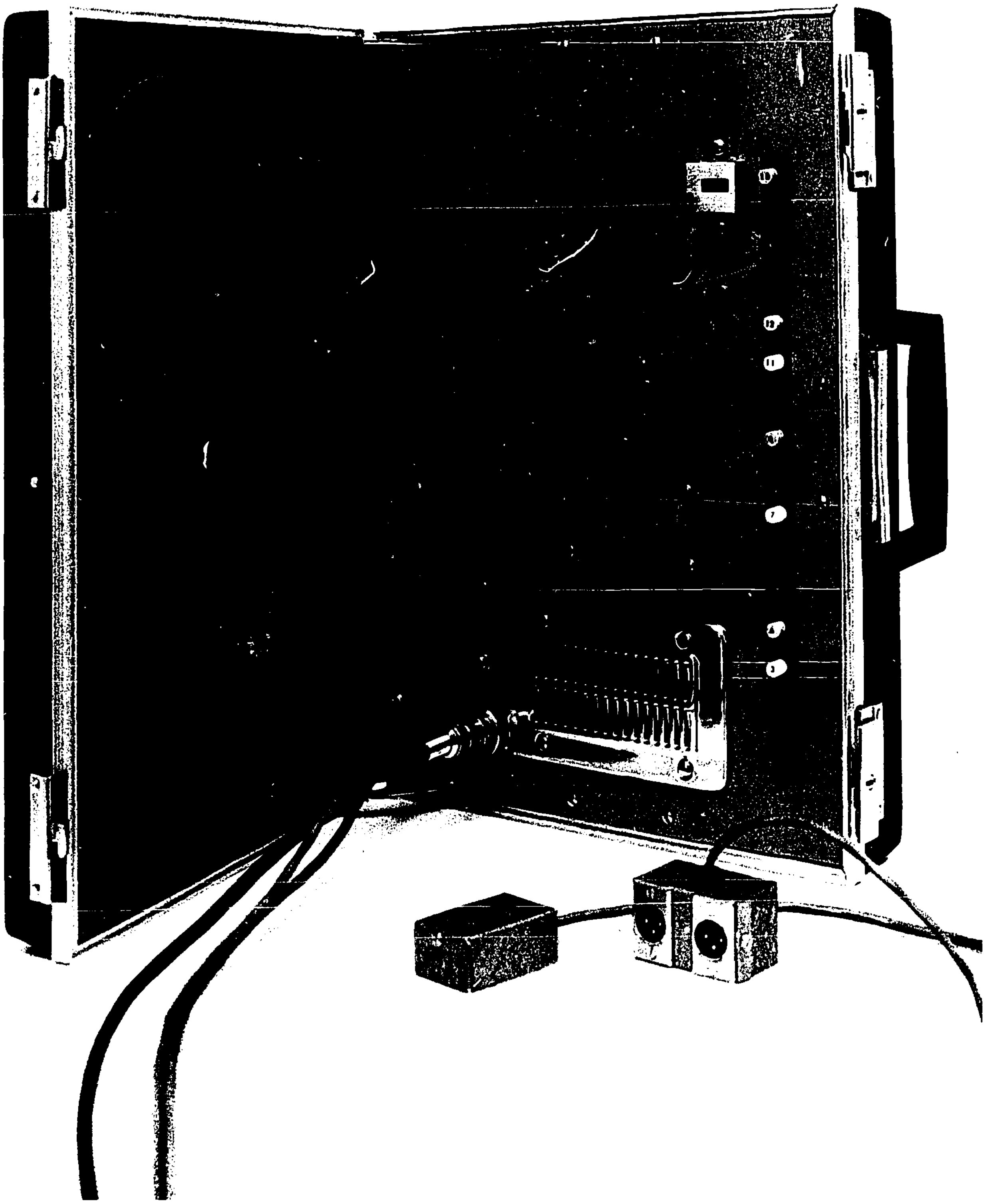


FIGURE 2

The Training

The training program had been elaborated before the beginning of the training period and was tried out on a normal population of third graders.

On the basis of the preliminary experimentations several dimensions were defined, along which sequences of balancing tasks could be arranged in ascending difficulty. (The designation of the postures and positions will be henceforth abbreviated, as indicated in parenthesis). One dimension is determined by the position of the two rails. The easiest one is the parallel position (N), the rails being 1-1/2" apart. Greater stability is required when one of the rails is shifted forward, so that the heel of the foot put in front is in line with the toe of the foot placed in the rear (MR).*

Pre-experimentation has shown that balancing becomes conspicuously more difficult when the distance between the rails is gradually shortened, while preserving the heel to toe position. Consequently, three increasingly difficult MR postures were designed (MR3, MR2, MR1) the number indicating inches of distance between the outer edge of one rail to the inner edge of the other one. In the traditional Romberg position the distance is zero, i.e. the two rails are then put one in front of the other. Finally, the child is asked to stand with one foot on one of the rails (OF). It can easily be seen that this dimension of difficulty consisted of the decreasing <u>width</u> of the area on which the subject is standing (See Figure 3).

* The abbreviations stand for N = Normal, MR = Modified Romberg, R = Romberg. Romberg is the name of the neurologist who invented the neurological test consisting essentially of asking the patient to stand heel to toe with eyes closed.

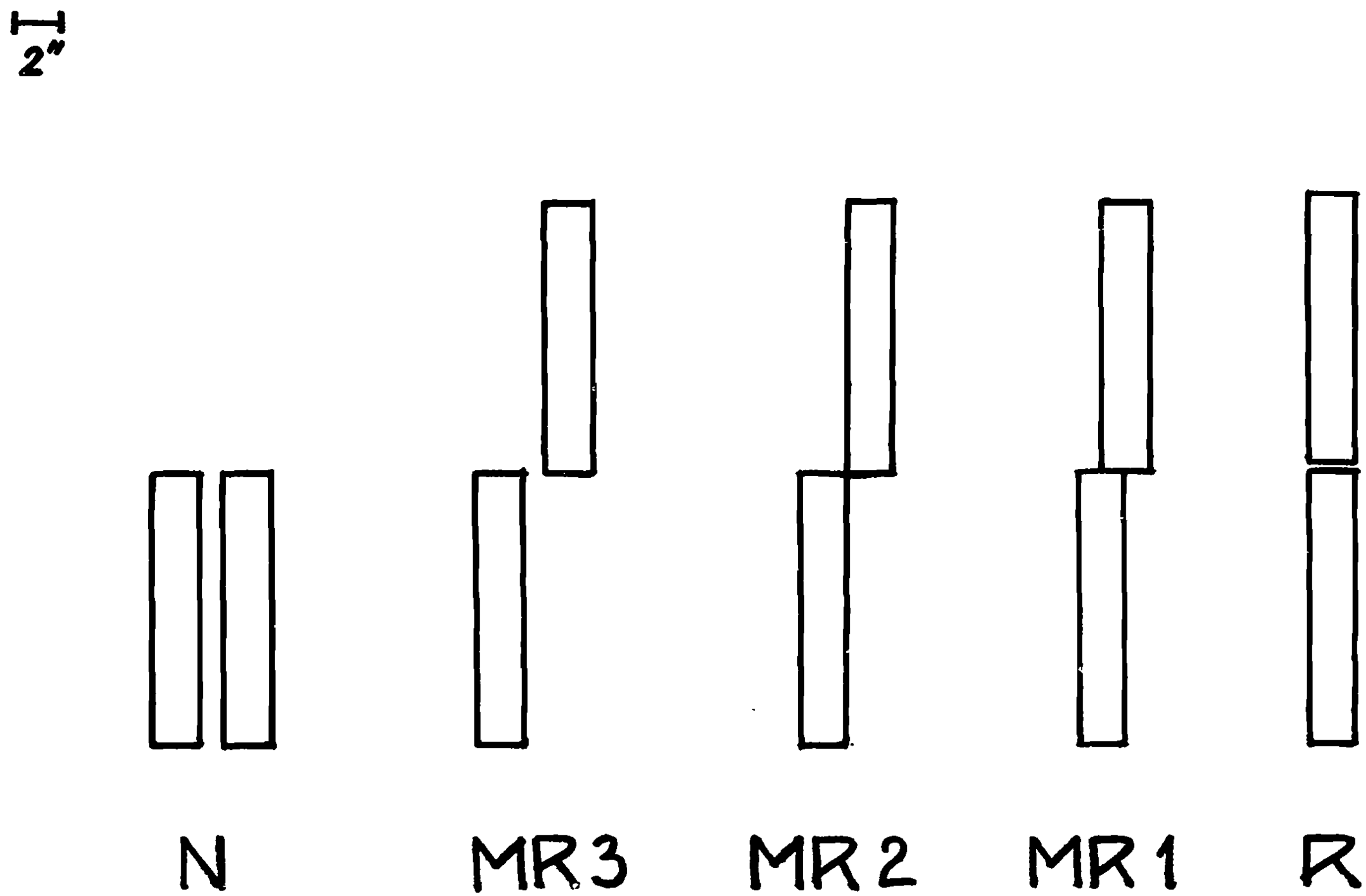


FIGURE 3

RAIL POSITIONS PROVIDING DECREASING WIDTH OF SUPPORT AREA

Other dimensions of difficulty were induced by tilting the rails horizontally (T), by asking the subject to close his eyes (C), to balance an object on the head (B) and to stand on tiptoes (TT). Finally, the tasks were rendered still more difficult by replacing the 2" rails by narrow rails of one inch width only.

Combining these dimensions, five programs of ascending level of difficulty were constructed and pretested. The structure of the programs is shown on Tables 3-5.

The sequence of administering the tasks was predetermined (See tables 3-5). Furthermore, the following scoring system was elaborated: The duration of the postures is limited to 10 or 20 seconds, depending on the difficulty of the task and level of the program. The performance time is measured by means of the feedback signals, consisting of a sequence of 16 lights and tones, each lasting 1.25 seconds. The trainer simply registers the number of the last among the 16 bulbs which lightens while the subject is still able to keep his balance. (Actually, the light and bell sequence stops automatically, when the stumbling child touches either handles or floor). When the child fails to control his equilibrium during the critical period of 10 or 20 seconds, he is given a second trial. The time of the two trials is summed as performance score. If the child succeeds to keep the balance on the first trial, his score is the criterion time multiplied by two, i.e., he is credited as if he had performed a perfect second trial.

TABLE 6

TRAINING PROGRAM, LEVEL I

	N	MR 3	MR 2	MR 1	R	N	OFL	OFR
O	1 #	3 #	5 #	7 #	8 X			
C1	2 #	4 #	6 #					
OB	9 #	11 #	13 #	15 #	16 X			
C1B	10 #	12 #	14 #					
OB TIL	17 #	19 #	21 #	23 #	24 X			
C1B TIL	18 #	20 #	22 #					
OTT	25 X	26 X						
C1TT								

Legend of posture abbreviations, see text.
Numbers indicate sequence of administration.

Administration time 20 seconds.
X Administration time 10 seconds.

TABLE 7

TRAINING PROGRAM, LEVEL II

	N	MR 3	MR 2	MR 1	R	N	OFL	OFR
O				1 #	3 X	4 *	5 X	6 X
C1		7 #	8 #	2 #				
OB				9 #	11 X	12 *	13 X	14 X
C1B		15 #	16 #	10 #				
OB TIL				17 #	19 X	20 *	21 X	22 X
C1B TIL		23 #	24 #	18 #				
OTT	25 #							
C1TT	26 #							

* Rest postures

TABLE 8

TRAINING PROGRAM, LEVEL III

	N	MR 3	MR 2	MR 1	R	N	OFL	OFR
O					1 X	3 *	4 X	5 X
C1					2 X	6 *	X<——>	7 X
OB					8 X	10 *	11 X	12 X
C1B					9 X	13 *	X<——>	14 X
OB TIL					15 X	17 *	18 X	19 X
C1B TIL					16 X	20 *	X<——>	21 X
OTT	22 #	24 #	26 #					
C1TT	23 #	25 #	27 #					

Training Level IV, as above, balancing on one hand plate and ball.

Training Level V, as above, width of rails 1"

The total performance time is then summed and computed as a percentage score of the total performance time required for a perfect performance on all the items of the program. When the child reaches a percentage score of 80 on levels I, II and III and a percentage score of 60 on level IV, the experimenter puts the child on the next higher training level.

Only one program is given during one session and its duration is approximately 25 minutes including instruction, shifting of rails, etc.

As can be seen on Tables 6-8 , "Rest postures" have been inserted in the form of N positions which are not scored.

In addition to these tasks to be executed on rails, "wiggling exercises" were given. The rails are placed horizontally over a fulcrum, and the child is asked to keep his balance "while wiggling".

When the rails touch the floor, the feedback apparatus stops and the performance can again be conveniently measured. Besides the scoring records, prepared by the examiner, the children keep their own scoring notes, i.e. after each training session, they write down the number of their perfect performances which are registered by the little counter placed on top of the feedback apparatus.

In order to keep track of his progress, each child is given an attractive colored booklet and a colored ball pen. These booklets and pens are kept in the examination room and given to the children at the end of the training as "à gift."

Watching the spectacle of lights and scrutinizing and controlling their own performance were considered to be adequate intrinsic rewards and consequently no other forms of extrinsic rewards such as candies, slips, tokens, etc. were offered to the child. The main reason for using this limited intrinsic reward system, besides being more rigorous as experimental procedure, was the endeavor not to interfere with the educational style of the EH class, where extrinsic rewards and incentives are not given because they seem to irritate the emotionally disturbed and motivationally confused student.

The Training Schedule

According to the design of the study, it was intended to train about 100 EH children in three experimental groups starting equal training periods at three different dates. This necessitated to form experimental groups of 33 to 35 subjects for each training period. Taking into account attrition, 36 per group was considered to be an optimal number. On the other hand, half-an-hour, three times per week, seemedto be a reasonable amount of training, taking into account the thresholds of tolerance of the EH children themselves as well as those of the teachers who are anxious not to disrupt the daily school routine.

Last but not least, the efficiency of the trainer to perform routine and monotonous training with presumably not easy manageable subjects had to be considered.

Finally the school day of EH children is short. Some of them leave school as early as noon, most of them between 1:30 and 2 P. M. and only a few stay after 2 P. M.

All these considerations lead to the design of a training schedule engaging one trainer to train a group of 12 subjects, 9 children per day four days per week in half-an-hour training sessions, thus giving training to 12 children, 3 half-hours per week to each child, as shown on Table 9 . Three trainers were thus able to train one experimental group of 36, preferably in three schools. The design, however, provided for the possibility to have one trainer working in two schools, shifting in the midst of the day from one school to another. (In such a case the platforms remained in each school, whereas the easily portable feedback apparatus was carried from one school to the other.)

To avoid trainer bias, trainers changed after 14 days, so that each trainer gave training to each subgroup of 12 during the six weeks experimental period.

Our greatest concern before the beginning of the training was whether the EH children would be motivated and be kept motivated to undergo a routine, structured half-an-hour training, three times per week for six weeks, not receiving any extrinsic reward. Cooperation on the part of the teachers and avoiding interference with the school routine was another envisaged problem. Finally, the experimenters' own motivation to keep alert and attentive was subject to some preoccupation.

In retrospect, it may be stated that none of these issues has raised serious problems or became an obstacle. First of all, no lack or drop in motivation on the part of the children was noted. Even the most unstable and erratic subjects liked the training, performed it according to

TABLE 9

THE TRAINING SCHEDULE OF ONE EXPERIMENTAL SUBGROUP OF 12 SUBJECTS HANDLED BY ONE TRAINER

(Numbers are designations of subjects)

	8:30 a.m. - 12						1 - 2:30 p.m.		
Monday	1	2	3	4	5	6	7	8	9
Tuesday	10	11	12	1	2	3	4	5	6
Wednesday	7	8	9	10	11	12	1	2	3
Thursday	4	5	6	7	8	9	10	11	12

schedule and were happy to have their booklets, called by some the "psycho-crylic" notebooks. Teachers were willing to cooperate and many of them were openly interested in the study itself. However, some of them insisted on rigorous scheduling, a plausible demand and easily to fulfill in view of the well prepared structure of the program. The testers enjoyed the variety of performances provided by the kaleidoscope of clinical types whom they encountered. This "intrinsic reward" provided to the trainer, was increased by his circulation between the groups. Also from the point of view of the children, it seemed advantageous to change trainers, who were different as to sex, age, character, appearance and approach to the child.

The only causes that children dropped out of training were moving out of town and long absence due to sickness.

Intensive Training

The intensive training consisted a) In extending the training period beyond six weeks; b) In augmenting the training sessions from three to five half-hours per week; c) Interspersing three intermediate levels of difficulty between 1 and 2, 2 and 3, and 3 and 4 respectively; d) repeating training on individual items, which were difficult for the child. On the non-intensive program only one repetition was given per item, in case of a first failure, but the next difficult items were administered irrespectively of a second failure or success.

The Method of Electronic Ataxiametry

The electronic ataxiameter consists of four footplates (for each heel and toe respectively), equipped with transducers, sensitive exclusively to vertical pressure. The electronic output of these transducers can be recorded by any conventional four channel registration apparatus and is objectively scorable, either by visual inspection or by computer techniques.

This output consists essentially of four waves, which depict the patterns of weight displacement over the four footplates, while the sum of deviations from the four base lines is constant and equals the body weight of the subject. (For specimen, see Appendix II).

To keep the child attentive, the same feeback toy apparatus is used as for training. (See above page 23).

The ataxiametric test battery consists of the following postures each to be kept for 15 to 20 seconds. (Henceforth they will be abbreviated as indicated in parentheses):

1. Standing normally with eyes open. The plates are placed one beside the other, without any space left between them. (NO).

2. Standing on left and right foot respectively, with eyes open (OF).

3. Standing normally, blindfolded. Same posture as 1. (NC).

4. "Modified Romberg" Position, eyes open. This posture is midway between normal standing and the Romberg (heel-to-toe) position, in that the heel of the right foot is placed to the right side of the left toe. (MO). (See Figure 3 on page 26).

5. "Modified Romberg" Position, blindfolded. (MC).

6. Romberg Position, left foot behind, eyes open. This is the traditional posture used in routine neurological examinations. The right heel is now placed in front of the left toe. (RO).

7. Romberg Position, left foot behind, blindfolded. (RC).

Three types of scores were elaborated, namely 1) A Fluctuation Score, indicating the sum of amplitudes per second, relative to the total body weight. 2) A Synchrony Score, measuring the constancy of even weight placement on two footplates (see below, page 40). 3) A Weight Displacement Score, indicating the average percentage of weight per second concentrated on one plate. (For further details of the scoring method and system, see Kohen-Raz, in press).

The computer program which scores the ataxiametric record has four stages:

Stage A. All the tape recorded data are played back into a polygraph to produce a visually inspectable ataxiagram. This is done for two purposes: 1) Certain qualitative features of the ataxiagram which may be important for clinical diagnosis are not picked up by the present quantitative computer analysis*; 2) Data must be visually scanned in order to correct eventual recording errors, to detect deviations from the standard procedure of measurement caused by erratic behavior of the Subject during the examinations and finally to check the exact location of the electronic marker signals, indicating the child's identity, the postures, start and end of experimental phases and incidence of failures or highly abnormal responses. (These signals are fed--in part automatically, in part manually--into the tape, by a specially constructed encoding device.)

Stage B. The tape recorded data are played back for a second time into an electronic system which transforms them into numbers, indicating weight displacements over the four footplates as measured by 25 units per second. The information, transmitted on five channels (two heel and two toe traces, and one array of marker signals) is temporarily stored in an auxiliary computor file.

Stage C. On the basis of visual inspection of the graphic data produced by Stage A, a signal input matrix is computed informing the computer about the location of the performance.

---

* See Appendix II

Stage D. Using the information provided by data processing of stages B and C, a specially designed computer program elaborates the ataxiametric scores.

Recently, however, a fully automatic computerized scanning of the signal channel has been elaborated, so that all three stages, digitizing, determination of signal matrix and scoring can be done by the computer. Both methods, manual and computerized signal input were checked one against the other and proved to be in perfect accordance. It was also necessary to check the reliability of the computer itself, by playing back the same ataxiametric record twice. It turned out that unless the electronic scanning is 25 units per second, the computer produces inconsistent scores.

As during any elaboration of computer programs, the problems were numerous. For instance, using the manual signal input method, a discrepancy of 40 milliseconds per second between the paper speed of the polygraph and the speed of the tape recorder feeding the ataxiametric waves into the computer obstructed the data elaboration. Once detected, it was easy to be corrected.

A crucial problem is the reliable measurement of the calibration signal (a weight of 5 kg is placed on the plates before the start of each group examination) and the determination of the zero line (when no weight is placed on the plates). Subtle changes in the zero line caused probably by the electronic instruments occur from examination to examination and therefore the computer program checks zero line and calibration before computing each performance. Defective data are immediately recognized and

flagged, so that the necessary corrections and check-ups can be fed in. The most sensitive index of a valid record is the sum of weight on the four plates which must approximate 100% on each posture. (See below).

The by-now available computer scoring program is obviously a great advantage to any future research in this area, as a large number of subjects can be examined on the ataxiameter and their performance reliably scored with relatively low budgetary investment.

Figures 4-7 show computerized scores and the corresponding traces reproduced by the pclygraph. As stated above, the essential parts of the scoring record are three types of scores: the X Scores, indicating the percentage of weight displacement on the four plates during the 8 postures, the F Scores measuring the amplitude of the ataxiametric waves and the S Scores, which reflect the coordination between two out of the four balancing centers, i.e. generally it is possible to keep balance while shifting the weight between only two support areas for instance, left heel and right heel. This will result in a constant sum of the weights placed on these two support areas, as the same amount of weight which is displaced from the right heel will be added to the left heel and vice versa. This shows up in a low synchrony score between right and left heel (which would be zero if all the weight would be exclusively balanced between these two). Good synchrony can also be recognized on the polygraph record by a symmetrical pattern of the two traces which measure the output of the respective pair of plates.

Bad synchrony on the other hand is manifest in diffuse wiggling and uncoordinated weight displacements over all of the four pressure plates. In such a case, the sums of weights placed on pairs of plates will fluctuate which results in a high synchrony score, and asymmetric traces on the polygraph records. (See specimen on Figures 4&5) .

Legend to Figures 4–7 Figures 4 and 5 show computerized ataxiametric scores for the whole test performance and polygraph record of heel to toe posture with eyes closed of Subject A. Note the good synchrony manifest in symmetric traces on the polygraph record and the low S scores of A on the score sheet. Figures 6 and 7 refer to Subject B, who is a considerably worse balancer and has a low synchrony. Key of Abbreviations: LH,RH,LT,RT = Left, Right Heels and Left, Right Toe. NO standing normally with eyes open, NC same posture eyes closed. OF standing on one foot. (On the computer score sheet, Left and Right Foot Postures are scored on same row, therefore sum of X scores approaches 200 percent of weight.) MO, MC, RO, RC are heel to toe postures with eyes open and closed respectively. In the M position, the feet are slightly apart.

XSCORES

	LH	LT	RH	RT	
NO	18.6	29.2	24.1	28.1	100.0
OF	31.6	60.0	35.7	68.7	195.9
NC	11.3	35.2	28.9	24.6	100.0
MO	25.2	49.8	18.0	6.3	99.3
MC	8.2	53.9	25.3	12.8	100.2
RO	10.4	56.5	18.8	11.8	97.5
RC	9.7	52.2	24.8	10.6	97.2

FSCORES

	LH	LT	RH	RT	/W	/sqrt(W)
NO	1.3	1.9	2.0	1.5	6.7	36.5
OF	4.6	4.5	7.5	5.1	21.6	117.0
NC	1.8	2.7	2.7	2.7	9.8	53.2
MO	3.4	4.9	3.5	1.3	13.1	70.8
MC	2.6	4.1	7.5	3.0	17.2	93.1
RO	2.9	4.5	6.6	2.4	16.3	88.4
RC	2.9	3.9	4.8	2.0	13.6	73.9

1/W	OPEN	36.2	CLOSE	40.7	CLOSE_OPEN	4.5
1/sqrt(W)	OPEN	195.7	CLOSE	220.1	CLOSE_OPEN	24.5

(C_O)/(C+O) ______ 5.9%

SSCORES

	LH_LT	LH_RH	LH_RT	LT_RH	LT_RT	RH_RT		
NO	2.6	2.3	1.4	1.4	2.1	2.9	12.8	69.3
OF	5.5	8.4	7.2	8.6	7.9	4.5	42.0	227.6
NC	4.2	2.2	1.8	1.9	2.2	4.8	17.2	92.9
MO	3.3	5.5	3.4	3.3	5.0	3.7	24.3	131.3
MC	4.4	8.2	3.1	4.0	6.6	5.5	31.9	172.6
RO	3.6	8.5	2.7	3.4	6.4	5.2	29.9	162.0
RC	4.0	5.7	2.9	3.7	4.8	5.0	26.1	141.1

1/W	OPEN	67.0	CLOSE	75.1	CLOSE_OPEN	8.1
1/sqrt(W)	OPEN	362.6	CLOSE	406.6	CLOSE_OPEN	43.9

(C_O)/(C+O) ______ 5.7%

FIGURE 4

FIGURE 5

```
                XSCORES
      LH     LT     RH     RT
NO  34.3   19.9   30.0   16.8          ______ 101.0
OF  53.8   47.3   61.3   49.2          ______ 211.6
NC  45.4   33.5   14.1   [illegible]   ______ 101.0
MO  41.2   40.4   15.1    4.4          ______ 101.1
MC  37.6   40.7   16.5    5.7          ______ 100.4
RO  44.0   42.2    9.0    4.6          ______  99.8
RC  47.1   33.1    8.2    5.1          ______  93.4


#           FSCORES                          /W                          /sqrt(W)
      LH     LT     RH     RT
NO    2.6    1.7    3.2    1.5   ____    9.0   ______________    42.8
OF    6.1    6.6    8.1    6.5   ____   27.3   ______________   130.4
NC    8.4   12.3    2.8    2.8   ____   26.3   ______________   125.6
# ACME GOES AT FIVE SHARP. THATS IN TWENTY MINUTES!!!!!
MO    4.9    7.7    2.4    1.7   ____   16.6   ______________    79.3
MC    7.6   11.3    4.4    2.3   ____   25.5   ______________   121.7
RO    7.5   10.8    3.1    3.3   ____   24.7   ______________   117.9
RC   13.8   14.7    5.6    5.1   ____   39.1   ______________   186.5

# 1/W         OPEN    50.3    CLOSE    90.9   CLOSE_OPEN    40.6
1/sqrt(W) OPEN   240.1    CLOSE   433.9   CLOSE_OPEN   193.8
(C_O)/(C+O) _____ 28.8%


#           SSCORES
   LH_LT  LH_RH  LH_RT  LT_RH  LT_RT  RH_RT
NO   3.4    2.9    2.7    2.8    2.7    3.6   ________   18.2 ______    86.7
OF   4.0   11.2    8.4    9.9   10.1    5.0   ________   48.6 ______   231.8
NC   5.8   10.0   10.2   10.8   10.5    5.2   ________   52.4 ______   250.1
MO   4.4    6.5    5.8    6.2    6.9    3.8   ________   33.6 ______   160.4
MC   6.4   10.5    8.8    8.3   10.2    6.3   ________   50.5 ______   240.8
RO   5.4    9.0    9.6    9.5    9.0    5.3   ________   47.7 ______   227.6
RC  11.2   14.6   15.7   14.0   13.2    8.8   ________   77.6 ______   370.0

# 1/W         OPEN    99.5    CLOSE   180.5   CLOSE_OPEN    80.9
1/sqrt(W) OPEN   474.7    CLOSE   860.9   CLOSE_OPEN   386.2
(C_O)/(C+O) _____ 28.9%
```

FIGURE 6

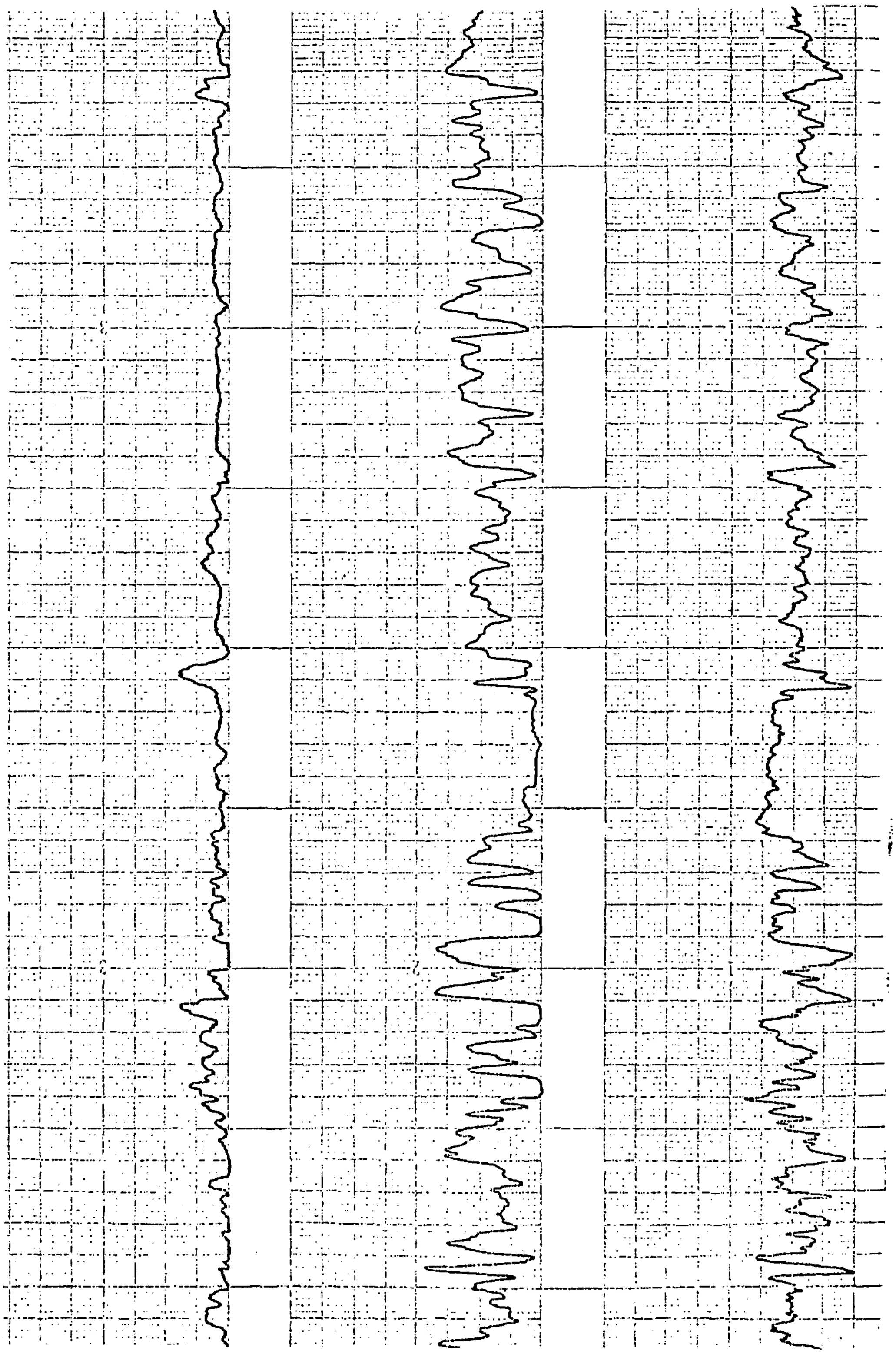


FIGURE 7

RESULTS

General Evaluation of Training Effects

In order to measure the effects of training on achievements and gains on the Metropolitan Tests, the scores had to be transformed into grade equivalents to make the results comparable across the three parallel forms (A. B, C) and the three test levels (Primary I, II, III) Non-readers, i.e. those students who could not be tested with the Primary I level even at the end of the intervention period were treated as a separate group and only the raw scores of the Metropolitan Readiness Test (Pre-reading level) were evaluated. Those pupils who at the beginning of the intervention period were non-readers, but later attained reading level, were included in the group of "readers". Their performance at the pre-reading level was then scored as being grade level 1.0 in order to be statistically comparable within the reader population.

Because of the data attrition caused by the high absentee rate (see above), training effects were elaborated in two steps. First, restricted samples of matched experimentals and controls who had participated at all four examinations were evaluated yielding a complete longitudinal comparison. Hereafter partial longitudinal comparisons were carried out by confronting the gains of experimentals and controls within all the possible combinations of the partial testing intervals of the whole intervention period, i.e. the intervals between examinations 1-2, 2-3, 3-4, 1-3, 2-3, 1-4. In this way those subject who had missed one or two examinations could be included in the data analysis. Combining and supplementing the findings of the complete and partial longitudinal follow-up, a fairly good estimate of the developmental patterns of the whole group could be obtained.

Because of the unequal sensitivity of grade level scores throughout their range, non-parametric statistics were used for data analysis. Means and Standard Deviations on the following tables are presented only for convenience of inspection. The significance of differences between achievements was assessed by means of the Mann Whitney U-test and between the gains of the matched pairs by means of the Wilcoxon matched pairs signed rank test.

The reader should be reminded that all the Experimentals have an initial lower reading level and that the three experimental groups and their respective controls differ as to their chronological age and intelligence level as shown on Table 3 on page 13.

Tables 11-13 reflect "complete" longitudinal patterns in restricted samples of experimentals and controls who participated in all four examinations.

There are no apparent training effects in Training Groups I and III. Experimentals and controls of Training Group I, while fluctuating in differing directions do not reveal any definitive pattern of improvement on the Reading subtest. On the Word Knowledge and Word Discrimination Tests, experimentals and controls show steady progress, the controls retaining their initial superiority.

Experimentals III are significantly lower in their achievements from the beginning of the intervention period and remain so in spite of the training given to them during the last two testing intervals. During the experimental phase they even tend to regress, while the controls continue to advance, thus creating a discrepancy in gains in favor of the controls.

Table 10

PERFORMANCE LEVELS ON METROPOLITAN ACHIEVEMENT TESTS
AT THE BEGINNING OF TRAINING PERIODS

(NON-READERS EXCLUDED)

Train. Group		Word Knowledge			Word Discrim.			Reading		
		N	M *	SD	N	M	SD	N	M	SD
I	EX	21	22.4	7.93	21	23.8	7.86	21	21.6	10.53
	CON	20	26.0	8.51	20	25.8	8.83	20	23.1	8.81
II	EX	26	23.5	7.26	26	26.6	8.20	26	19.9	6.60
	CON	27	26.4	8.27	27	29.1	9.34	25	25.7	8.31
III	EX	17	18.9	6.75	17	20.7	7.55	17	17.3	6.38
	CON	18	22.3	6.63	18	24.6	8.08	18	21.8	6.30

* Means are Tenths of Grade Equivalents

*Table 11

LONGITUDINAL COMPARISON OF ACHIEVEMENTS ON METROPOLITAN TEST

Training Group I

Experimental Period

Examination		1		2		3		4	
		M	SD	M	SD	M	SD	M	SD
READING N = 9	EX	24.2	12.65	21.7	6.32	20.7	6.65	23.2	6.34
	C	22.3	8.17	20.3	7.11	25.4	9.03	24.9	8.78
WORD KNOWL N = 11	EX	22.1	8.48	23.7	9.48	24.6	9.35	25.2	8.48
	C	26.7	7.13	26.0	7.25	28.8	7.45	32.0	11.18
WORD DISCRIM N = 8	EX	24.1	7.66	27.3	10.73	27.8	7.83	29.6	7.76
	C	24.6	7.21	24.5	7.13	27.3	8.84	31.3	7.59

*All Means on Tables are Tenths of Grade Equivalents.

Table 12

LONGITUDINAL COMPARISON OF ACHIEVEMENTS ON METROPOLITAN TESTS

Training Group II

Examination		Experimental Period 1 M	1 SD	2 M	2 SD	3 M	3 SD	4 M	4 SD
READING N = 12	EX	22.5	10.85	22.9	7.47	24.4	9.97	28.3	7.41
	C	21.5	9.43	23.7	6.12	25.1	7.85	25.9	6.87
WORD KNOWL N = 14	EX	20.0	8.66	24.4	8.39	27.5	10.19	29.3	8.95
	C	24.6	8.32	26.0	7.60	25.1	7.12	27.8	9.54
WORD DISCRIM N = 14	EX	22.3	11.36	26.6	9.04	28.8	9.29	31.4	10.84
	C	25.1	11.10	29.4	9.54	29.6	9.91	29.4	8.00

Table 13

LONGITUDINAL COMPARISON OF ACHIEVEMENTS ON METROPOLITAN TESTS

Training Group III

		Experimental Period 1 M	1 SD	2 M	2 SD	3 M	3 SD	4 M	4 SD
READING N = 9	EX	16.7	6.93	20.3	7.11	19.2	4.92	18.2	4.41
	CON	23.9	6.01	24.0	5.7	23.1	7.11	25.4	6.78
WORD KNOWL N = 8	EX	18.6	4.57	18.3	5.50	19.3	4.59	20.8	5.09
	CON	23.5	7.54	28.8	8.31	26.5	9.30	27.5	11.48
WORD DISCRIM N = 8	EX	19.6	4.21	19.4	5.7	23.6	7.05	21.8	4.95
	CON	26.5	8.07	28.9	12.7	28.3	8.55	30.9	11.03

In contrast to these findings, Experimentals II who are at the first examination substantially equal to their controls on the Reading sub-test, and inferior to them in Word Knowledge and Discrimination, show a steady increase in their performance, while the controls, sharing with the experimentals an initial gain during the pre-experimental period, level off and are surpassed by the experimentals during the post-experimental phase. (Figure 8).

Thus, the stagnation in the progress of the controls can hardly be attributed to a ceiling effect, besides the fact that the ceiling of the test as well as that of the expected achievement of these potential third graders at the end of the scholastic year is close to 4 (40 units on our tables).

Neither the superiority nor the relative gains of the experimentals reach levels of statistical significance in relation to the controls on the separate subtests. However, when the total test performance is evaluated (Table 14), the gains of the experimentals, being even those of the controls during the pre-experimental period are significantly higher during the experimental and post-experimental periods.

These results based on a complete longitudinal follow-up in a restricted part of the sample will now be checked against the partial longitudinal findings derived from a considerably larger number of subjects (Tables 15-17).

Experimentals I show a tendency toward higher gains relative to the controls, a pattern which was not apparent in the restricted sample The differences, however, are not significant except for Discrimination during

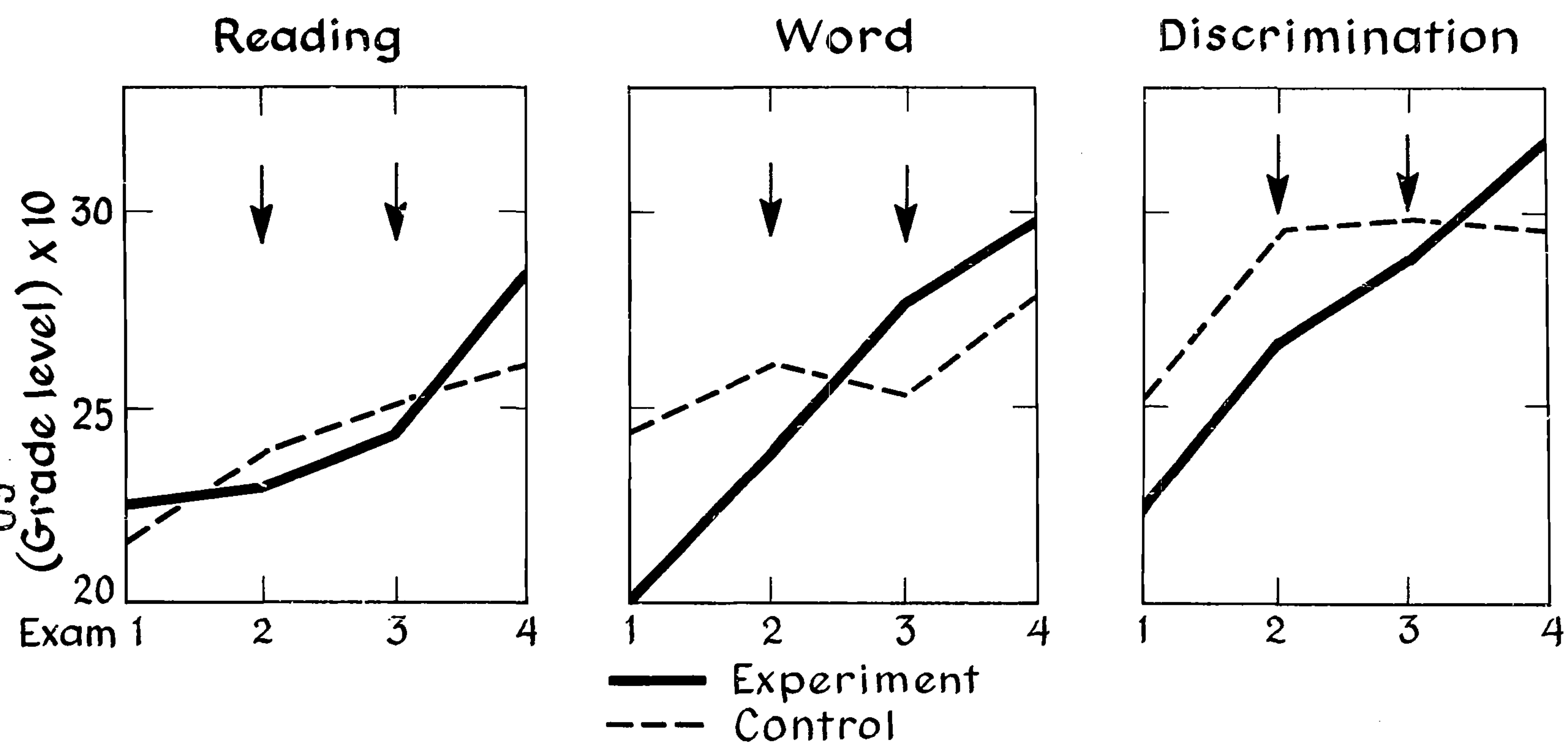


FIGURE 8

LONGITUDINAL COMPARISON OF ACHIEVEMENTS ON METROPOLITAN TESTS

Arrows indicate experimental period

Table 14

LONGITUDINAL COMPARISON OF TOTAL GAINS
ON METROPOLITAN ACHIEVEMENT TESTS

Training Group II

		Pre-Exper Period			Exper. Period			Post Exper. Period			Experim. & Post Ex. Combined	
Exam. Intervals		1-2			2-3			3-4			2-4	
	N	M	SD	N	M	SD	N	M	SD	N	M	SD
TOTAL GAINS EX	12	8.1	14.66	12	*5.6	11.49	12	**11.7	10.89	12	***17.2	7.03
TOTAL GAINS CON	12	8.2	10.35	12	-2.8	6.61	12	5.4	7.74	12	2.7	10.19

* P = .1
** P = .05
*** P = .002

the experimental period. The overall picture of the partial longitudinal comparison in Group II is generally consistent with the results of the complete follow up, in that a definitive shift in relative gains on the Reading and Discrimination tests occurs in favor of the experimentals after the beginning of the training, these gains becoming significantly higher in the post-experimental period. In Word Knowledge the experimentals show significantly higher gains already in the pre-experimental phase retaining their superiority in gains during the experimental and post-experimental periods. However, closer inspection of the date reveals that this high initial gain of the experimentals is entirely due to progress of the weaker students in the lowest quartile on the simplest items of the picture vocabulary part of this test, whilst gains during the experimental and post-experimental period represent advances on the more difficult parts accomplished by the students in the second and third quartiles. (See Table 18).

In Group III, it is the controls who show better gains in Reading and discrimination during the experimental period -- a pattern which is already apparent in the restricted sample -- whilst the experimentals seems to gain more in Word Knowledge. Obviously, the higher gains of the controls are plausible in view of their initial significant superiority in reading level.

Overviewing these findings, it seems that if there is any effect of short term balance training, it is apparent only in Training Group II which has a higher I. Q. and relatively lower age level. In order to estimate the eventual impact of these two variables on the training, all subjects of Group I whose age was below 9 were analyzed separately. This resulted in a sub-group of not exactly paired but as a group matchable 10 experimentals and 9 controls who fully participated on the second and fourth mental examination (See Table 19). In contrast to the results in whole Group I (comprising

the higher age groups) the experimentals of this younger sub-sample "catch up" with the initially superior controls at the end of the scholastic year, a pattern similar to that apparent in Training Group II. The combined gains in Reading and Work Knowledge of the experimentals are higher than those of the controls at the .11 level of significance. (Table 20).

Table 15

PARTIAL LONGITUDINAL COMPARISON OF GAINS ON METROPOLITAN TESTS

Training Group I

Examin. Intervals		Experimental Period 1-2			Post Exper. Period 2-4			Experimental & Post. Ext. Combined 1-4		
		N	M	SD	N	M	SD	N	M	SD
READING	EX	14	-1.1	7.10	19	4.3	5.32	14	3.4	10.82
	CON	14	-1.1	6.21	19	2.4	5.31	14	2.8	4.10
WORD KNOWL	EX	17	1.8	4.32	19	3.1	3.06	18	5.3	5.67
	CON	17	- .9	4.78	19	3.1	5.41	18	3.1	3.81
WORD DISCRIM	EX	12	5.0**	6.19	19	1.9	6.93	14	6.4	4.54
	CON	12	-1.0	3.59	19	4.8	6.71	14	4.9	4.81

** P = .02

Table 16

PARTIAL LONGITUDINAL COMPARISON OF GAINS ON METROPOLITAN TESTS

Training Group II

		Pre-Exper. Period			Exper. Period			Post Exper. Period			Experimental and Post-Exper. Combined		
Examin. Intervals		1-2			2-3			3-4			2-4		
		N	M	SD	N	M	SD	N	M	SD	N	M	SD
READING	EX	16	.9	7.97	26	1.9	5.26	23	3.2*	5.18	21	5.0	4.54
	CON	16	2.8	4.84	26	1.0	3.66	23	1.5	3.20	21	3.4	4.07
WORD KNOWL	EX	18	4.9*	4.31	26	2.0	5.61	24	2.3	3.75	21	4.7	4.73
	CON	18	1.7	4.47	26	1.3	5.39	24	1.8	4.37	21	3.2	5.76
WORD DISCRIM	EX	17	4.8	6.51	26	2.9	5.13	23	4.0**	5.64	21	6.2	5.43
	CON	17	4.2	5.51	26	2.1	7.64	23	.4	4.26	21	2.4	2.43

* P = .05

**P = .01

Table 17

PARTIAL LONGITUDINAL COMPARISON OF GAINS ON METROPOLITAN TESTS

Training Group III

		Pre-Experimental Period			Experimental Period		
Examin. Intervals		1-3			3-4		
		N	M	SD	N	M	SD
READING	EX	9	3.1	2.71	16	- .1*	3.75
	CON	9	-2.1	6.09	16	2.6	3.80
WORD KNOWL	EX	11	1.1	2.43	16	1.6	3.60
	CON	11	1.5	3.45	16	.3	2.27
WORD DISCRIM.	EX	11	2.3	6.00	16	- .3	6.55
	CON	11	1.3	6.10	16	2.8	5.40

* P = .05

TABLE 18

CROSS SECTIONAL DATA OF PROGRESS
IN WORD KNOWLEDGE

GROUP II

		EXPER.				CONTROLS			
	EXAM	N	Q_2	Q_1	Q_3	N	Q_2	Q_1	Q_3
	1	23	19.0	10.0	26.5	23	22.0	17.8	26.5
x x	2	27	19.0	16.8	25.8	25	22.0	17.3	29.8
EXP.PERIOD x x	3	27	23.0	18.0	26.5	27	24.0	18.0	30.5
	4	27	27.0	19.0	28.8	22	25.0	19.0	32.0

Table 19

TRAINING GROUP I

IQ AND AGE OF YOUNGER SUBSAMPLE

	AGE			IQ		
	N	M	SD*	N	M	SD
EX	10	7;10	12	10	85.2	6.11
CON	9	7;9	12	9	84.9	8.36

*SD in months

68

Table 20

TRAINING GROUP I

LONGITUDINAL COMPARISON OF ACHIEVEMENTS ON METROPOLITAN TESTS

Younger Subsample

EXAM.		1			2			3			4		
		N	M	SD	N	M	SD	N	M	SD	N	M	SD
READING	EX	8	12.5	3.25	10	13.5	5.54	9	15.8	7.46	10	18.2	8.07
	CON	6	14.8	3.87	9	15.0	5.66	6	18.5	5.21	9	17.7	6.52
WORD KNOWL.	EX	8	13.6	4.31	10	16.3	8.18	9	19.0	7.75	10	20.6	8.86
	CON	6	17.8	5.6	9	18.0	7.97	6	19.7	5.54	9	20.6	6.91
WORD DISCRIM.	EX	10	14.0	5.04	10	18.8	9.94	9	19.2	7.58	10	21.5	9.90
	CON	5	17.2	6.22	9	19.1	7.69	7	19.8	6.64	9	22.9	9.85

As the I. Q. of this sub-group is even lower than that of Groups I and III (Table 19 P 61), it appears that age and not intelligence is eventually the decisive factor causing the discrepancy in responsiveness to short term training between Training Group II and Groups I and II respectively.

Training Effects on Non-Readers

As already stated, the definition of "non-readers" was given to those experimentals and controls who did not reach reading level at the end of the scholastic year. Six experimentals in Training Group I, one in Training Group II and eight in Training Group III fall in this category (Total N = 15). The Mean age of this group is 8 and their Mean I. Q. 83. Eleven out of the 15 did show only slow progress in their balance performance after six weeks training and were thus defined as "Low Trainables". Five out of the Low Trainable Non-readers were then given intensive training until the end of the scholastic year. None of these 15 experimentals, and neither the five among them who were given intensive training showed any progress on the Metropolitan Readiness Test (Pre-Reading Level), nor did their controls. (See above).

Effects of Intensive Training

As reported above (P. 35), the intensive training was given to the so-called "Low Trainables". Altogether 13 subjects were involved, one of them left school two weeks before the termination of the scholastic vear and could not be evaluated. Five out of the remaining 12 remained non-readers and no progress whatsoever was detectable on the Metropolitan Readiness Tests (see above). The progress of the seven "readers" is shown on Table 21.

Table 21

LONGITUDINAL PROGRESS OF "LOW TRAINABLE" READERS UNDER INTENSIVE TRAINING (TOTAL TEST PERFORMANCE IN GRADE EQUIVALENTS)**

		Intensive Training 1		2		3		4		IQ	AGE
AL		16		14		16		19		90	6;02
	CON	+	15		15		18		20	90	6;02
WIL		14		14		17		19		72	8;07
	CON	+	*[10]		[10]		[10]		[10]	72	8;02
PET		23		27		30		30		80	9;00
	CON	+	21		20		19		23	88	9;05
BOB		16		17		15		17		83	8;10
	CON	+	28		31				31	78	8;10
TOM		15		18		17		17		90	8;09
	CON			+	10		22		22	95	8;07
KIR		10		12		16		15		92	8;00
	CON			+	10		15		15	88	8;05
MIC		10		15		17		21		90	8;07
	CON		10	+	14		18		20	85	8;10

*Control subject is non-reader and no adequate match.

+ Indicates start of regular training.

** Scores are Tenths of Grade Equivalents.

Although five out of the seven, viewed individually, show good progress, which is higher than would be expected during such a short period in a normal population studying in an age adequate grade, comparison with carefully matched controls does not show any superior gains in relation to the latter. However, these controls, who were selected on the basis of I. Q., age, sex and reading ability (neglecting father's occupation) are not necessarily matched for balance trainability (which cannot be assessed). Furthermore, all the Low Trainables included in the program of intensive training had been defined by their teachers as the most difficult and slowest progressing students prior to the training, which is not the case with the controls. In any case, the intensive training did not produce any tangible and clear-cut results at this moment. As it was short termed and no follow-up has yet been carried out for "delayed effects", it seems worthwhile to recommend a limited continuation and an additional retesting after the beginning of the new scholastic year.

Analysis of Effects of Intervening Variables

As Experimentals and Controls could be matched only by age, intelligence, father's occupation and balance ability, the eventual effect of intervening, non-matchable variables on the above reported findings must now be examined.

As can be seen on Table 22 a significant difference in length of stay in EH class between Experimentals and Controls showed up in Training Group II, the Experimentals being definitevly the seniors. If it is assumed that length of stay in the EH class is concomitant with a more extensive exposure to the various treatment methods offered there to the individual pupil then it would seem at first sight, that what was previously reported as possible impact of balance training is not but the cumulative beneficial influence of special education.

However, it remains to be explained why - in spite of such assumed cumulative stimulation - the Experimentals are worse readers prior to the experimental period than the controls who spent less time in EH classes (See above Table 10 , p. 48). It seems that there is an additional inverse relationship between scholastic progress and duration of placement in EH units, namely the slower learner requires more time to be able to return to a normal classroom and thus remains longer in the special education set up.

The availability of longitudinal data opened the possibility to explore this issue from a different angle, namely by computing correlations between scholastic achievement and duration of stay in the EH class <u>within</u> the experimental and control group during pre-experimental, experimental and post-experimental periods. Concentrating first on Training Group II,

TABLE 22

LENGTH OF STAY IN EH CLASS
(IN MONTHS)

	EX			CON		
GROUP	N	M	SD	N	M	SD
I	20	15.2	7.1	22	17.0	8.4
II	27	16.4*	6.8	26	13.5	7.4
III	16	14.1	5.5	14	13.0	5.9

* P = .05

where the question is of crucial importance, there is no apparent relationship between reading achievement scores on examinations 1, 2 and 3 and stay in EH class. However positive significant correlations appear at examination four , six weeks after the termination of the training in the experimental group (Table 23). When relative gains are used as criterion of progress, the experimentals show a rather drastic change from significant negative correlations in the pre-experimental, to significant positive correlations in the post-experimental period. No such pattern is apparent in the Controls although one correlation is found in the pre-experimental period with the Discrimination sub-test. (Table 24). Computing finally the relationship between the differences in reading gains and differences in stay in EH class within the pairs of matched experimentals and controls in the restricted but fully longitudinally followed up subsample (see above p. 50) a decisive change from zero to positive correlation shows up during the experimental period.(Table 25).

Analysing the data for Training Groups I and III, the relationship between stay in EH class and scholastic achievement is predominantly either absent or negative. However - again on the Discrimination test, we find significant positive correlations in Experimentals I and in Controls III. In the latter group a drastic inversion occurs between testing periods which however could be due in part to fluctuations of N in this very small sample.

Overviewing these findings, it seems that while stay in EH class is sporadically related to gains in Word Discrimination, it correlates positively and significantly with gains and achievements in reading and word knowledge exclusively in Experimental Group II during the experimental

TABLE 23

CORRELATIONS BETWEEN SCORES ON METROPOLITAN TESTS AND LENGTH OF STAY IN EH CLASS

GROUP II

GROUP	PERIOD	EXAM INTERVAL	READING N	READING RHO	WORD N	WORD RHO	DISCRIM N	DISCRIM RHO
EX II	PRE	1	(22)	.28	(23)	.26	(22)	.28
	PRE / EX	2	(27)	.24	(27)	.21	(27)	.21
	EX / POST	3	(27)	.20	(27)	.22	(27)	.09
	POST	4	(26)	.43*	(27)	.37*	(27)	.09
CON II	PRE	1	(18)	-.36	(22)	.02	(21)	-.06
	PRE / EX	2	(23)	-.09	(24)	.01	(24)	.04
	EX / POST	3	(26)	-.04	(26)	-.18	(26)	-.22
	POST	4	(22)	-.10	(22)	-.08	(22)	-.16
EX II & CON II COMBINED	PRE	1	(40)	-.01	(45)	.06	(43)	.04
	PRE / EX	2	(50)	.03	(51)	.08	(51)	.09
	EX / POST	3	(53)	.02	(53)	.01	(53)	-.07
	POST	4	(48)	.14	(48)	.13	(49)	.05

TABLE 24

CORRELATIONS BETWEEN GAINS ON METROPOLITAN TESTS AND LENGTH OF STAY IN EH CLASS

GROUP II

GROUP	PERIOD	EXAM INTERVAL	READING N	READING RHO	WORD N	WORD RHO	DISCRIM N	DISCRIM RHO
EX II	PRE	1-2	(22)	-.31	(23)	-.37*	(22)	-.36*
	EX	2-3	(27)	-.16	(27)	.04	(27)	-.15
	POST	3-4	(26)	.38*	(27)	.20	(27)	.33*
CON II	PRE	1.2	(16)	.21	(20)	.16	(1[illegible])	.55*
	EX	2-3	(23)	-.25	(24)	-.25	(23)	-.25
	POST	3-4	(22)	.11	(22)	.21	(22)	.21
EX II & CON II COMBINED	PRE	1-2	(38)	-.02	(43)	-.01	(41)	.16
	EX	2-3	(50)	-.17	(51)	-.04	(51)	-.20
	POST	3-4	(48)	.30*	(49)	.19	(49)	.29*

TABLE 25

CORRELATIONS BETWEEN DIFFERENCES IN GAINS ON METROPOLITAN TESTS AND DIFFERENCES IN STAY IN EH CLASS IN MATCHED PAIRS OF EXPERIMENTALS AND CONTROLS

GROUP II

		READING		WORD		DISCRIM	
	EXAM INTERV	N+	RHO	N	RHO	N	RHO
PRE	1-2	(12)	.08	(12)	.00	(12)	.16
EX	2-3	(12)	.65*	(12)	.43	(12)	-.29
POST	3-4	(12)	.05	(12)	-.23	(12)	-.02

+ N is number of matched pairs
* P = .05

TABLE 26

CORRELATIONS BETWEEN GAINS ON METROPOLITAN TESTS AND LENGTH OF STAY IN EH CLASS

GROUPS I & III

GROUP	PERIOD	EXAM INTERVAL	READING N	READING RHO	WORD N	WORD RHO	DISCRIM N	DISCRIM RHO
EX I	EX	1-2	(18)	-.16	(18)	-.26	(18)	.43*
	POST	2-3	(18)	-.54*	(18)	.26	(18)	-.15
	POST	3-4	(17)	.30	(17)	-.19	(17)	-.12
CON I	EX	1-2	(15)	-.50*	(16)	.10	(12)	-.57*
	POST	2-3	(17)	.19	(17)	-.08	(18)	.10
	POST	3-4	(19)	.09	(19)	-.05	(20)	.06
EX III	PRE	1-2	(13)	-.43	(14)	-.28	(13)	-.53*
	PRE	2-3	(14)	.16	(16)	.06	(15)	.26
	EX	3-4	(14)	.20	(14)	.30	(14)	.33
CON III	PRE	1-2	(5)	.41	(7)	.68	(7)	.71*
	PRE	2-3	(10)	-.27	(10)	-.24	(10)	-.69*
	EX	3-4	(14)	.06	(14)	.24	(14)	.62*

* P = .05

and post-experimental periods. Unless we assume that the beneficial effect of remedial instruction has critically culminated and suddenly shown up by accidental coincidence during our experimental period in Experimentals II we are tempted to propose the following hypothesis which, if verified by further research would have important consequences: Certain types of EH children, such as represented in Experimental Group II, do not greatly profit from their stay in EH classes unless a crucial factor of their learning disability probably related to weak balance ability, is treated.

Obviously, to prove this hypothesis a sample matchable for length of stay in EH class, in addition to IQ, age, reading level, etc. would have to be trained in balance so that the interaction between balance training and duration of stay in EH class could be measured. At this moment, the possibility that balance training combined with other remedial methods would induce scholastic progress in some types of EH children seems to be more plausible and also more promising than assuming that balance training per se would produce such effects by its own merits.

It can now be seen that without a longitudinal design and without sampling EH students exclusively from EH classes, such possible interaction could never have been traced.

Another intervening variable which recently has become increasingly important is the widespread administration of drugs, mainly ritalin and dexedrin to the hyperactive Educationally Handicapped students. About 40% of the population in our study is treated with drugs, although there are conspicuous variations in our subgroups. (Table 27). There is no difference in percentage of drug treatment in Training Groups I and III, but Experimentals II were given significantly less drugs than their controls. Actually Experimentals II are the least drug affected subpopulation. The differences in the nonreader group are insignificant because of the smallness of the sample.

As to the possible contamination of our findings on balance training by drug administration, there is obviously no effect on experimental differences between Experimentals and Controls in Groups I and III, who seem to be well matched on this intervening variable. Experimental Group II is practically "drug free" and no effect of drugs on balance training can be present. However, it may be speculated that there may be two possibilities of drug effects on Controls II blurring experimental differences. It could be that drugs have a depressing influence on scholastic achievement and the gain of the Experimentals would then be due to the discrepancy created by this depression. On the other hand, if drugs have a stimulating effect on the child's learning ability, the alleged influence of balance training on reading would be greater than apparent from our results. In the first case it would have to be explained why the drugs started to depress the Controls during the experimental period as their administration started long before our intervention. Another question

which may be asked is, whether the absence of training effects in Experimentals I and III might not be due to depressing drug interference which is obviously not the case in Experimental Group II.

In any case the patterns of scholastic progress within the short intervention period of our study in all the drug recipient groups compare unfavorably with those of the "drug free" Experimentals II, a finding which may be important by its own merit.

As to effects of other special treatments, it will be noted on Table 27 that a considerable percentage of Controls II have been given individual reading and mathematic lessons as well as physical training in contrast to the relatively "neglected" Experimentals II. This however would indicate that balance training was effective in spite of and eventually more than these methods. Finally it will be noted that the general physical training given to more than half of Experimentals III seemed to have no effect on scholastic progress in view of our negative findings reported on Table 17, page 59.

TABLE 27

FREQUENCY OF SPECIAL TREATMENTS
IN SUBGROUPS

(in percentages)

	PSYCHO THER.	SPEECH THER.	INDIV. READING LESSONS	INDIV. MATH LESSONS	PHYSIO. THERAPY	PHYSICAL TRAINING	ORTHO PED. TREAT	ART & MUSIC	DRUGS	N
EX I	17	17	17	17		17			46	24
CON I	4	17	17	13		29			42	24
EX II	15	4					4		15	27
CON II	4	7	48	30		33			56	27
EX III	13	38	31	31		56		31	38	16
CON III		25	25	19	6	19			44	16
EXNR	29	14	43	14		43			57	7
CONR		43	43			43			14	7
EXNOM	21	21	29	14		21		7	21	14
REM	6	20	16	7	2	24		4	27	76

The last group of unmatched intervening variables to be considered are symptoms and handicaps, possible representative of certain clinical groups. As can be seen on Table 28 , Groups I and III turn out to be fairly matched, except a somewhat higher incidence of bedwetting and class disruptive behavior in Controls III. In Group II controls show higher frequencies of acting out types and minimal organic brain damage, whilst the experimentals have more vision problems. This latter finding may in part explain why so many subjects in control Group II are under drug treatment, chiefly intended to "calm the child down" and to make him accessible to educational contact and influence.

TABLE 28

INCIDENCE OF SYMPTOMS AND HANDICAPS
(IN PERCENTAGES)

N =	24	24	27	27	16	16	7	7	23	76
	EX I	CON I	EX II	CON II	EX III	CON III	EXNR	CONR	EXNOM	REM
Bedwetting	21	21	4	11	19	25	14	14	17	10
Phobia	4		4	15		6			4	
Compulsory	8	4				6				5
Grand Mal	4	4							13	1
Petit Mal			4	4		6	29			3
Stealing		13		4		6				1
Destructive Behavior	4	4		7	13	6	14		4	3
Attacks Persons		13	4	19	13	6	29			1
Verbal Aggress			4	15			14		4	2
Disrupts Class	25	29	19	37	13	25	29			12
Neurol. Findings	38	38	15	19	25	25	14	14	25	22
Vision Problems	21	13	63	37	50	44	14	14	38	26
Auditory Problems		13	11	15	13	6				10
Min. Org. Brain Damage	38	38	19	37	44	19	57	29	21	30

Trainability in Static Balance as Independent Variable

The structured training program and its objective scoring method produces measurements of "trainability" computed by assessing the differences between initial and final training level. As can be seen on Table 29 trainability in static balance is significantly related to I. Q. the relationship being more pronounced when the lowest age groups (under 7) is excluded, the latter being composed predominantly of low trainable non-readers with low intelligence (Table 29). In addition, trainability seems to be stronger correlated with Performance I. Q. than with General I. Q. whilst actually it is not correlated with Verbal I. Q. (Table 30). Finally, there is a significant correlation between trainability and achievements on the Reading and Word subtests prior to the intervention. (Table 31 , last column). This fact, that actually reading ability "predicts" balance trainability, blurs the possibility to present the crucial proof, that balance training produces gains in scholastic achievements by correlating trainability with reading gains during the experimental and post experimental periods. That is to say because better readers are implicitely better trainable on balance, no clear cut interpretation of whatever results is possible. In case a positive correlation would show up between trainability and reading gains, it could be due to the initial reading advantage of the "better trainables". In case negative or zero correlations appear, their meaning would be ambiguous, i.e. it could simply be interpreted as absence of relationship or else, that even though the worse readers do not show high gains in final training level,

Table 29

RELATIONSHIP BETWEEN TRAINABILITY IN STATIC BALANCE AND IQ

Total Sample of Trainees

Trainability	IQ 90 and below	IQ 91 and above
High	19	36
Low	11	11

$X^2 = 6.501$ P = .02

Trainees under age of 7

Trainability	IQ 90 and below	IQ 91 and above
High	3	7
Low	4	4

N.S.

Trainees age 7 and above

Trainability	IQ 90 and below	IQ 91 and above
High	16	35
Low	15	7

$X^2 = 7.889$ P = .01

TABLE 30

CORRELATIONS BETWEEN TRAINABILITY AND IQ

	N	RHO
GEN. IQ	(82)	.26*
PERF. IQ	(62)	.29*
VERBAL IQ	(61)	.20

TABLE 31

CORRELATIONS BETWEEN SCORES ON METROPOLITAN TESTS
AND TRAINABILITY IN STATIC BALANCE

EXAMINATION		EX I N	EX I RHO	EX II N	EX II RHO	EX III N	EX III RHO	ALL EXPER. N	ALL EXPER. RHO
READING	1	(20)	.37	(18)	.33	(13)	.37	(62)	.25*
	2	(23)	.37	(23)	.31	(16)	-.17		
	3	(21)	.21	(22)	.45*	(16)	.54*		
	4	(22)	.24	(22)	.32	(16)	-.08	(71)	.10
WORD	1	(21)	.33	(19)	.33	(14)	.01	(62)	.23+
	2	(23)	.12	(23)	.29	(16)	.09		
	3	(21)	.08	(23)	.39+	(16)	.26		
	4	(22)	.20	(23)	.37	(14)	.19	(71)	.16

* P = .05

\+ P approaches .05

they nevertheless profited from the balance training and gained more in reading than the better readers whose potential reading gains through balance training may have already been "exhausted" prior to the experimental period, i.e. their reading and balance ability may have spontaneously improved or matured before our intervention started.

The empirical findings presented on Tables 31 and 32 are as follows: The significant positive relationship between trainability and Reading and Word subtests at the first examination disappears at the last examination in the total sample of experimentals, i.e. after all of them have passed training. Analysing separately the experimental subgroups, there is a general decline of correlations towards the end of the intervention period, preceded by significant peaks in Experimentals II and III and the end and at the beginning of their training respectively. Comparing the relationship between gains on the reading tests with trainability during the testing periods in the experimental subgroups correlations are near zero with sporadic two negative and one positive significant correlation. The overall gain during the intervention period on the Discrimination subtest is significantly positively correlated.

As already stated, no clear interpretation of these findings is possible. The fact that towards the end of the intervention period trainability ceases to be related to achievement and tends to be negatively correlated with gains leaves the way open to assume, that it is the lower

trainables who have profited more from the training, progressed more in their reading ability, and thus caused a levelling off of the correlations or even turned them into negative.

TABLE 32

CORRELATIONS BETWEEN TRAINABILITY
AND GAINS ON METROPOLITAN TESTS

		EX I		EX II		EX III	
	EXAM INTERVALS	N	RHO	N	RHO	N	RHO
	1-2	(20)	.09	(18)	-.19	(13)	-.37
READING	2-3	(21)	.02	(23)	-.03	(16)	.51*
	3-4	(20)	-.17	(22)	.11	(14)	-.62*
	1-2	(21)	.02	(19)	-.16	(14)	-.42
WORD	2-3	(21)	-.15	(23)	-.12	(16)	.43
	3-4	(20)	.05	(23)	.33	(14)	.07
	1-2	(21)	.39	(18)	-.06	(13)	.20
DISCRIM	2-3	(21)	.05	(23)	.28	(15)	.05
	3-4	(20)	-.58**	(23)	.02	(14)	-.05

ALL EXPERIMENTALS

READING	1-4	(56)	-.11
WORD	1-4	(60)	-.06
DISCRIM	1-4	(59)	.26*

Results of Ataxiameter Measurements

The first step in the data elaboration of the computorized ataxiametric scores was the assessment of their test retest reliability after 4 1/2 months. The correlation coefficients shown on Table 34 refer to items of 20 seconds duration. Taking into consideration the period elapsed between the two measurements of such brevity, the fluctuation scores of items OF and MC, synchrony scores of MC, and weight displacement scores of NO (LH + LT) and RO (LH + RT) were regarded as relatively "reliable" and applied as representative measures in the assessment of relationships between static balance and scholastic achievements of EH students. As MC fluctuation and synchrony scores intercorrelated very highly*(.98) and RO and NO weight displacement scores showed up to be insensitive to reading level, only OF fluctuation, MC synchrony and a combined score of MO weight displace + OF fluctuation were used in our final data analysis as presented on Tables 34 to 41.

Comparing the static balance ability of the various subgroups on Table 36 , it can be seen that Experimentals I and II are well matched with their respective controls the whole Group II having somewhat lower balance control. However, Experimentals III perform worse than their controls and worse than all the other Experimental Readers which would well correspond to their low reading level and weak progress in reading in spite of balance training. Finally, the lowest balance ability is that of the Non-Readers (experimentals and controls) which is significantly below the rest of the sample. The lower level of Experimentals III and Low Trainables is actually not surprising, as during training period III we tried to focus on subjects with low balance and envisaged low trainability, in order to test our "intensive training" program. (See above, page 17 and 35).

* See Table 35

TABLE 33

TEST RE-TEST CORRELATIONS OF ATAXIAMETRIC SCORES

Fluctuation and Synchrony Scores
N = 46

	NO	OF	NC	MO	MC	RO	RC
FLUCTUATION	.27	.49	.21	.39	.48	.36	.32
SYNCHRONY	.26		.19	.32	.45	.28	.34

TABLE 34

Weight Displacement Scores
N = 45

	LH + LT	LH + RH	LH + RT
NO	.28	.66	.30
NC	.02	.23	.50
MO	.66	.31	.39
MC	.53	.27	.34
RO	.26	.46	.54
RC	.30	.04	-.01

TABLE 35

INTERCORRELATIONS BETWEEN ATAXIAMETRIC SCORES

	OF FLUCT	MC FLUCT	MC SYNCH	MO W.D.	NO W.D.
OF FLUCT	x	.61	.62	-.03	.04
MC FLUCT		x	.98	.06	.08
MC SYNCH			x	.12	.10
MO W.D.				x	.36
NO W.D.					x

TABLE 36

ATAXIAMETRIC SCORES IN VARIOUS SUBGROUPS

		EX I	CON I	EX II	CON II	EX III	CON III	EXNR	CONR	EXNOM	REM	LOW TRAINABLES
	N	20	17	21	18	6	10	5	4	11	39	10
OF (FLUCT)	M	15.7	16.2	17.3	16.3	20.7	16.3	21.0	24.3	16.0	19.0	23.1
	SD	5.7	6.5	7.5	5.3	7.1	8.8	2.3	9.2	7.1	7.3	7.6
MC (SYN)	M	30.0	33.2	31.7	32.0	32.1	26.5	35.6	41.8	32.4	33.4	34.8
	SD	9.3	13.7	8.7	8.4	5.9	9.5	8.8	13.6	10.5	10.1	11.7
MO(WD) + OF(SYN)	M	84.1	84.5	93.7	92.3	89.3	86.5	95.6	101.3	89.8	93.7	
	SD	13.9	8.1	9.1	8.8	7.3	16.4	20.0	14.1	10.6	11.8	

Table 37 shows correlations between balance ability and reading. There is a substantial relationship between the Metropolitan tests and balance ability in the experimentals taken as a whole group. The correlations are highest with the Reading subtest and lowest with the Discrimination subtest, in the latter sometimes below the level of significance. This is in line with finding of our Pilot Study (Kohen-Raz, 1970) where the Stanford Word and Paragraph Meaning subtests showed high correlations with ataxiametric scores, whilst close to zero correlations were found with the phonetic discrimination "Vocabulary" test. It should be noted that the non-readers with low balance scores are excluded from the correlation computations reported above. If this would not be the case, the correlations would be higher by virtue of extension of range.

The most pronounced relationship between reading and balance ability show up in Experimentals I.

On the other hand, there are only two sporadic correlations in the controls (OF with Word in Controls III and MS with Discrimination in Controls I) whilst in the controls as a whole, the relationship is absent. In Controls II it even tends to invert, in that better balancers are worse readers, which seems to indicate that we are dealing with a type of EH population which is different from Experimentals II in many respects. This has already been manifested before in the context of inspecting the frequency of drug administration, incidence of symptoms and application of special treatment methods.

TABLE 37

CORRELATIONS BETWEEN ATAXIAMETRIC SCORES
AND METROPOLITAN TESTS

		EX I		CON I		EX II		CON II		EX III		CON III		EXNOM		REM		TOTAL EXPERIM.		TOTAL CONTROLS	
		N	RHO	N	RHO	N	RHO	N	RHO	N	RHO	N	RHO	N	RHO	N	RHO	N	RHO	N	RHO
OF (FLUCT)	READING (1)[+]	17	-.47*	17	-.01	17	-.23	13	.36	5	-.36	8	-.49	9	-.43	17	.06	48	-.34	35	-.02
	WORD (1)	18	-.59**	15	-.09	18	-.24	15	.42	5	.20	9	-.63*	9	-.19	17	-.01	50	-.30*	39	-.03
	DISCRIM (1)	20	-.15	17	.06	17	-.13	15	.25	5	.20	8	-.56	9	-.11	17	-.05	49	-.13	34	-.04
MC (SYNCHRONY)	READING (1)	17	-.66**	14	-.30	20	-.33	14	.58*	8	-.17	8	-.34	10	.39	18	-.03	55	-.31*	36	.08
	WORD (1)	18	-.66**	15	.02	20	-.34	16	.25	9	-.38	9	-.52	10	.45	18	.00	58	-.30*	40	.05
	DISCRIM (1)	18	-.41*	11	-.57*	20	-.32	16	.30	9	-.40	8	-.28	10	.49	18	.01	57	-.22	35	.07
COMBINED MO (WD) + OF(FL)	READING (1)	18	-.42	14	.10	17	-.23	13	.40	5	-.87	8	.00	9	-.49	17	-.05	48	-.40**	35	.13
	WORD (1)	18	-.59**	15	.16	18	-.29	15	.69**	5	-.60	9	-.47	9	-.54	17	-.30	50	-.41**	39	.11
	DISCRIM (1)	18	-.35	11	.10	17	-.19	15	.58*	5	-.60	8	-.20	9	-.40	17	-.31	49	-.32*	34	.15

[+]First examination
*P = .05
**P = .01

It must still be asked why experimentals and controls turned out to be so different as to the relationship between balance ability and reading, whilst their ataxiametric scores (in Groups I and II at least) are well matched.

It seems that this is due to the fact that experimentals had been recruited from a more limited pool of EH children, as they had to be concentrated in a certain school where at least 50% incidence of low balance ability was found (See above page 11). Thus, it was more likely to sample a certain type of EH child (namely the one in whom balance and reading impairment are correlated) as certain school and districts seemed to have selected him as "the" EH type to be given placement priority in EH classrooms. Whilst other schools and districts might have shown preferences for other types (namely those whose balance and reading are predominantly uncorrelated) we abstained from sampling them as experimental subjects, as their general balance ability seemed to be high. When finally controls were selected to match the experimentals, they not only were pooled from more districts and schools, but also from a population in which uncorrelated balance and reading was more frequent.*

In any case, these findingsdemonstrate that in at least 40% to 50% of EH children, balance ability and balance impairment seems to be a factor in their reading problems. These results also indicate that ataxiametric measurements might turn out to be a useful tool for differential diagnosis between at least two different types of EH students.

---

* As evident from the frequency distributions in our Pilot Study, this absence of correlations is due to the fact that in these populations there are many good balancers who are bad readers, as their learning difficulties seem to be primarily caused by neurotic conflicts, unrelated to neurological weakness.

As to the relationship between I. Q. and balance ability, the only significant correlation (in inverted direction) was found between Verbal I. Q. and of fluctuation (Table 38) in the controls. It will be remembered that Verbal I. Q. was actually not correlated with trainability also in the experimentals so that this isolated finding does not contradict the presence of correlations between trainability and Performance I. Q. found in the experimentals (above page 81).

As to the <u>longitudinal</u> dimensions of ataxiametric relationships, balance scores do not predict gains on the Metropolitan tests, neither in the experimental, nor in the control groups. (Table 39). However, there is some indication that improvement in balance as measured by OF is related to improvement in reading in experimentals although the number of comparable subjects is extremely small. (Table 39).

Trainability is predicted by the OF score at the .01 level of confidence. On the other hand, trainability tends to be correlated, albeit only marginally, with static balance <u>improvement</u> as measured by the ataxiametric scores (Tables 40,41).

In light of the generally low test-retest correlation between ataxiametric scores, the effect of training on eventual changes in these scores is difficult to assess unless measurements are taken within short time intervals during which training would be too short to be effective. On the other hand, as ataxiametric scores are substantially correlated with reading level prior to any training, proving the effectivity of balance training on reading ability by demonstrating concomitant improvement in

TABLE 38

CORRELATIONS BETWEEN ATAXIAMETRIC SCORES AND IQ

		GEN IQ		PERF IQ		VERB IQ	
		N	RHO	N	RHO	N	RHO
OF FLUCT	EXP	(49)	.23	(43)	-.17	(43)	-.10
	CON	(47)	.10	(37)	.11	(39)	.45**

TABLE 39

CORRELATIONS BETWEEN ATAXIAMETRIC SCORES
AND TOTAL GAINS (EXAMIN. 1-4) ON
METROPOLITAN TESTS

		READING		WORD		DISCRIM	
		N	RHO	N	RHO	N	RHO
OF(FL)	EXP	(53)	.18	(46)	.10	(45)	-.17
	CON	(33)	.01	(36)	.02	(31)	.07
MC(SYN)	EXP	(51)	.17	(54)	.08	(53)	-.14
	CON	(33)	.09	(36)	-.12	(31)	.35*
MO(WD) + OF(FL)	EX	(43)	.20	(46)	.30	(45)	-.06
	CON	(33)	.11	(36)	.16	(31)	.11

* P = .05

CORRELATIONS BETWEEN GAINS ON METROPOLITAN TESTS
(FIRST AND LAST EXAMINATION)
AND PROGRESS ON ATAXIAMETRIC SCORES
(TEST-RETEST)

	READING		WORD		DISCRIM	
	N	RHO	N	RHO	N	RHO
OF FLUCT	11	-.52+	11	.40	11	.34

TABLE 40

CORRELATIONS BETWEEN ATAXIAMETRIC SCORES AND TRAINABILITY

(All Experimentals)

	N	RHO
OF(FL)	(56)	-.40**
MC(SYN)	(66)	-.17
MO(WD) + OF(FL)	(56)	-.10

TABLE 41

CORRELATIONS BETWEEN TRAINABILITY AND IMPROVEMENT IN BALANCE ABILITY AS MEASURED BY ATAXIAMETRIC TEST-RETEST

	N	RHO
OF(FL)	(13)	.18
MC(SYN)	(23)	-.39+
MO(WD) + OF(FL)	(17)	-.38

**P = .01
+P approaches .05

balance ability is impossible because of the same reasons cited in relation to trainability (See above p 83).*

In view of the relationship between stay in EH class and reading progress analysed above (P 66), it was of interest to inspect correlations between stay in EH class and ataxiametric scores. As can be seen on Table 41 , the findings are negative.

Comparing the ataxiametric scores in groups of EH children characterized by various symptoms, clinical diagnosis of minimal organic brain damage and drug treatment (Table 42) some patterns can be observed which, however, in light of the small number of subjects in each subgroup, must be interpreted with caution. **

Children characterized by acting out (stealing, verbal aggression, aggression towards persons and disruptive class behavior) seem to have lower balance ability than neurotic types (bedwetters, and children with phobias and compulsory behavior). Also those diagnosed as having minimal organic brain damage perform worse on the ataxiametric test. However, those with grave destructive behavior and epileptics with grand mal (in contrast with those suffering from petit mal only) have conspicuously low ataxiametric scores, which would be indicative of good static balance. It might be that this is due to special types of drugs administered to these children or else that the intensive discharge of tensions through epileptic fits and destructive rages is linked to a different structure of nervous control which in turn is manifest in a different ataxiametric syndrome.

*As reported above (p.18) for reasons of technical failure of the equipment about 50 % of our ataxiametric retest data required special and expensive retrieving procedures in order to be computorized, which in light of these considerations were not worthwhile at this stage. Therefore the seize of our presently available atxiametric test-retest data is relatively small.

** None of the differences reported in the following sections are significant.

TABLE 41

CORRELATIONS BETWEEN STAY IN EH CLASS
AND STATIC BALANCE IN GROUP II

	EX II		CON II	
	N	RHO	N	RHO
OF(FL)	(21)	.31	(17)	-.08
MS(SYN)	(25)	-.10	(18)	-.29
MO(WD) + OF(FL)	(21)	.02	(17)	.20

TABLE 42

ATAXIAMETRIC SCORES IN GROUPS OF EH CHILDREN
CHARACTERIZED BY SYMPTOMS, CLINICAL DIAGNOSIS
AND DRUG TREATMENT

	MS (SYN)			OF (FLUC)			MO (WD)		
	N	M	SD	N	M	SD	N	M	SD
Bedwetting	(28)	30.3	10.7	(25)	16.4	5.9	(30)	71.2	12
Phobia	(7)	31.0	8.5	(8)	17.6	6.9	(8)	77.6	6.1
Compuls. Behavior	(6)	31.5	10.1	(5)	16.8	7.3	(6)	68.5	
Grand Mal	(4)	29.8	10.7	(4)	15.5	3.7	(4)	81.5	8.6
Petit Mal	(3)	34.7	12.3	(3)	26.7	13.3	(3)	72.7	11.1
Stealing	(5)	41.2	17.1	(5)	18.0	3.8	(5)	72.2	5.0
Destructive Behavior	(7)	27.0	7.5	(8)	16.0	4.2	(8)	73.6	5
Attacks Persons	(13)	33.8	10.8	(12)	18.0	6.2	(12)	75.8	9.2
Verbal Aggress	(8)	38.5	9.9	(8)	19.8	5.9	(8)	71.9	6.5
Disrupts Class	(36)	33.1	10.0	(34)	18.2	6.6	(36)	72.4	10.3
Neur. Findings	(34)	29.4	6.8	(28)	16.9	7.5	(37)	72.3	9.4
Min. Org. Brain Damage	(50)	32.0		(46)	18.0	7.2	(50)	71.0	11.7
Drugs	(55)	31.7	9.8	(50)	18.5	7.4	(54)	71.7	12.0

Subjects who receive drugs have a generally lower balance ability. This would not be surprising as it is the acting out types who are under dosage.

This purely quantitative analysis of ataxiametric differences between clinical groups does not exhaust all the possibilities of differential analysis on the basis of qualitative inspection of the polygraph records. Although our experience up to date is too limited to define "typical patterns" of disturbances, the specimen shown in Appendix II seem to be promising. However a much greater quantity of data is needed in order to classify these records according to clinical groups.

THEORETICAL OUTLOOK

Before concluding this report, some findings of recent neuro-physiological research will be cited which seem to be relevant to our findings and may possibly serve as a theoretical basis for the continuation of our investigation.

It seems that the neuro-physiological process which would account for the linkage between static balance and cognition is the integration of so-called "alpha" and "gamma" innervatory activities, as will be explained below:

There is evidence from animal studies that on the sensori-motor level "tonic readiness" of the muscle affected by the so-called "gamma innervation" precedes the overt motor response which uses different, slower pathways called "alpha routes". (Bergman 1969, Granit 1958, Harris 1969). The latter are more resistant to conditioning and are more susceptible to extinction than the aforementioned "gamma loops", which seem to be a mechanism of alterness preparing the motor act. The degree of this tonic readiness, as well as the patterns of interaction between the alpha and gamma innvevation pathways is regulated by central control mechanisms assumedly located in the upper brain stem and cerebellum (Magoun 1964, CIBA SYMPOSIUM 1967). It is probable that the efficiency of this interaction determines the degree of static balance ability as inefficient proprioceptive feedback and insufficient tonic readiness in the leg muscles will lead to exaggerated wiggling and loss of equilibrium.

It may be stated in somewhat oversimplified way that the aforementioned neurological mechanism, of efficient interaction between tonic readiness and motor response is the basis of attention and concentration and eventually linked to rapid feedback of information presented in minute temporal sequences (Pribram 1969). To assume an intrinsic relationship between such a function and reading ability seems to be not too farfetched.

DISCUSSION

The basic hypothesis of the study that static balance plays an important role in learning difficulties of Educationally Handicapped children has been substantiated. First, significant correlations have been found between ataxiametric scores and reading ability in the experimental population which irrespective of having or not having profited from balance training, turns out to represent a certain type of EH students with "balance related" learning problems. These children can be differentiated from a second type whose difficulties seem to have no relationship with equilibrium control, the proportion of the two types being approximately half-and-half. Independently from the ataxiametric diagnosis, based on items of 20 seconds duration, "trainability" in balance as measured by the gross performance on the training apparatus throughout six weeks, has shown to be related to initial reading level, as well as to intelligence being definitively correlated with performance but not with verbal IQ. The fact that the relationship of trainability with initial reading level vanishes at the end of the training period could be an indirect indication that balance training improves reading in the worse readers/balancers, provided that better readers/ balancers have eventually reached a ceiling of interaction effects between balance and reading ability prior to the training or shortly after its start. Most of the worst readers and non-readers have been shown to be unable to progress in reading as well as in balance, in spite of intensive training, during a limited period of 12 weeks except a few individuals among these "lost cases" whose conspicuous progress, however, did not contrast sufficiently with that of controls matched for I. Q. and age.

One experimental group of average intelligence and below the age of 9 seemed to have made scholastic progress under the impact of short term balance training in comparison to a control group matched for I. Q., father's occupation and ataxiametric performance. None of the additional aspects on which the controls differed substantially and in part significantly from the experimentals appears to provide sufficient disproof of the demonstrated training effect. The controls received more special treatment and had a higher reading level which surely puts the experimentals at disadvantage. So does the higher frequency of visual problems in the experimentals. About half of the controls were administered drugs, while the experimentals were practically "drug free". However, no relative superiority in achievements and gains in reading ability in the experimentals, eventually due to depressing drug effects in the controls, was noticeable prior to the training. The same applies to other clinical differences, possibly linked to drug treatment, namely the higher incidence of minimal brain damage and acting out in the controls.

Finally, the experimentals stayed a longer time in the EH class, but again this factor, which generally tends to be negatively related to reading level, was present in the pre-experimental period during which the experimentals were definitively the worse readers. Surprisingly, a closer analysis of correlations between reading achievements and gains and stay in EH class within experimental Group II lead to an important accessory finding, namely that a drastic shift from zero or negative to a significantly positive relationship occurred between the pre and post experimental periods.

If this phenomenon could be replicated, it would lead us to assume that balance training "triggers off" a mechanism, making the child attentive, perceptive and absorbing the stimulation provided to him by the special education, whilst before he seemed to have been insensitive to the latter. The abruptness of the change would indicate that such a mechanism appears to be more neurologically rooted than behaviorally organized.

In fact, that the two other experimental groups, as well as the so-called "low trainables" did not show any scholastic progress produced by the training, indicates that if a training effect was present in experimental Group II, it could not be contaminated by "attention giving" or by the peculiar reinforcement produced by the contact with the trainer. By the way, the great variety of treatments given otherwise to the student in the EH class seems to desensitize him considerably to individual attention.

Overviewing the findings of this study, it seems that some new insight has been gained on certain important aspects of diagnosis and treatment of Educationally Handicapped children. Although it was impossible to control all the variables involved, and to manipulate populations of EH students according to a rigorous experimental design, the impact of teacher, teaching methods, Halo and Hawthorne effects were optimally eliminated by wide-spread sampling and longitudinally spaced intervention procedures, monitored by repeated retesting. By virtue of this additional longitudinal control meaningful results could be obtained and interpreted, and although they may not convey definitive proofs, they pave the way to the systematic exploration of basic issues in the field of Education of the Handicapped.

REFERENCES

1. Akerblom, B. Standing and sitting posture. Diss. med. Stockholm. Karolinska Institutet, Stockholm: A-B, Nordiska Eokhandeln, 1948

2. Bergmans, J., and Grillner, S. Reciprocal Control of Spontaneous Activity and Reflex Effects in Static and Dynamic Flexor Gamma Neurons. Acts Physiol. Scand., 1969, 77, 106.

3. Boman, K., and Jalvisto, E. Standing steadiness in old and young men. Ann. med. exper. & biol. Fenniae, 31, 447, 1953.

4. C.I.B.A. Foundation Symposium on Myotatic Kinesthetic and Vestibular Mechanisms. 1967, London: Church, J. A. Ltd., 1967.

5. Fearing, F. S. The factors influencing static equilibrium. Journal of Comp. Psychology, 4: 91, 1924.

6. Fleishman, E. A. The dimensions of physical fitness. Yale University, New Haven, Conn. 1962.

7. Fregly, A. R. and Graybiel, A. An ataxia test not requiring rails. Aerospace Medicine, 39; 277, 1968.

8. Granit, R. Neuromuscular Interaction in Postural Tone in the Cat's Isometric Soleus Muscle. Journal of Physiology (London), 1958, 143, 387.

9. Hancock, J. A. A preliminary study of motor ability. Pedagogical Seminary, 3:9, 1894.

10. Harris, F. A. Control of Gamma Efferents through the Reticular Activating System. American Journal of Occupational Therapy, 1969, 23, 397.

11. Hellebrandt, F. A., and Braun, G. L. The influence of sex and age on the postural sway of man. Amer. J. Phys. Antrop. 24, 347, 1939.

12. Hicks, H. J. The mechanics of the foot. J. of Anat. 87:345, 1953, J. of Anat., 88:25, 1954.

13. Holbrook, S. F. A study of the development of motor abilities between the ages of four and twelve. Doctoral dissertation, Univ. of Michigan, Ann Arbor, Mich. University Microfilms, 1953, No. 5537.

14. Joseph, J. Man's posture. Electromyographic studies. Springfield, Ill.: Thomas, 1960.

15. Keogh, J. Motor performance of elementary school children, Los Angeles: Department of Physical Education, UCLA, 1965.

16. Keogh, J. F. Analysis of individual tasks in the Stott Test of motor impairment. Los Angeles: Department of Physical Education, UCLA, 1968.

17. Keogh, J. F., and Oliver, J. N. A clinical study of physically backward ESN boys. Research Quarterly, in press.

18. Kohen-Raz, R. Movement representations and their relation to the development of conceptual thought at early school age. Scripta Hierosolymitana. Vol. XIV, Jerusalem: Magnes Press, 1965.

19. Kohen-Raz, R. Developmental Patterns of Static Balance Ability and their Relation to School Readiness. Pediatrics, In press.

20. Kohen-Raz, R A clinical test of motor development. Publications of the School of Education. The Hebrew University, Jerusalem, 1965.

21. Magoun, H. W. The Waking Brain. Springfield, Ill. Thomas, 1964.

22. Mann, R., and Inman, V. I. Phasic activity of intrinsic muscles of the foot. J. of Bone and Joint Surgery, 1964, 46A, 469.

23. Leger, W. Die Form der Birbelsaule mit Untersuchunger uber ihre Beziehung zum Becken und die Statik der aufrechten Haltung. Beilage zur Zeitschrift fur Orthoadie, 91: 1959.

24. Miles, W. R. Static equilibrium as a useful test of motor control. J. of Industrial Hygiene, 3: 316, 1922.

25. Oseretzki, N. Methoden zur Untersuchung der Motorik. Z. fur Angewandte Psychologie, 17: 1, 1931.

26. Orma, E. J. The effect of cooling the feet and closing the eyes on standing equilibrium. Acta. physiol. scand. 38: 288, 1957.

27. Piaget, J. Le Probleme neurologique de l'interiorisation des actions en operations reversibles. Arch. Psychol. Geneve, 32: 241, 1947-1949.

28. Pribram, K. (Editor). On the Biology of Learning. New York: Harcourt, Brace and World, 1969.

29. Rey, A. L'evolution du comportment interne dans la representation du mouvement. Arch. Psychol. Geneve, 32: 209, 1947-1949.

30. Rothschild, F. S. Posture and Psyche. In: Halpern, L. Editor: Problems of Dynamic Neurology. Jerusalem: Hebrew Univ. Medical School, 1963.

31. Schilder, P. Mind, perception and thought in the constructive aspects. New York: Columbia Univ. Press, 1942.

32. Seashore, H. G. Postural steadiness under conditions of unusual tension and fatigue. Psychol. Records, 2: 319, 1938.

33. Skaggs, E. B. Attention and body sway. Amer. J. of Psychol., 44: 749, 1932.

34. Sloan, W. The Lincoln Oseretzki Scale. Genet. Psychology Monographs, 51: 183, 1955.

35. Smith, J. W. The forces operating at the human ankle joint during standing. J. of Anat., 91: 545, 1957.

36. Stott, D. H., Moyes, F. A., and Headridge, S. E. Tests of motor impairment. (3rd revision). Guelph, Ontario, Canada: Dept. of Psychology, Univ. of Guelph, 1968.

37. Uexkull, J. Theoretische Biologie. Berlin, Springer, 1926.

38. Werner, H. and Wapner, S. Sensory-tonic field theory of perception. Journal of Personality, 18: 88, 1949.

APPENDIX I

CASE HISTORY SAMPLING RECORD

CASE NO......................SCHOOL..................CITY..............SEX........

BIRTH DATE..................AGE AS PER SEPTEMBER 1969...............................

RACE........................ADMISSION DATE TO EH CLASS..............................

PART I. PARENTS

1) MARITAL SITUATION

In Household: (encircle)

Bio. Fa. Biol. Mo. Step Fa. Step Mo.

Adopt. Fa. Adopt. Mo.

Not living with parents but...............................

....

2) EDUCATION

	less than 8	8	9-11	12	13 and above
Fa					
Mo					

3) OCCUPATION

Father..............................Approx. income............

Mother..............................Approx. income............

4) PROBLEMS

	FATHER	MOTHER
Phys. Handicap		
Phys. chron. disease		
Mental disease		
Emotional disturbance		

PART II. S I B L I N G S

1) CONSTELLATION

1	2	3	4	5	6	7	8	9	10

X subject brother sister step sibling

deceased

2) PROBLEMS

Sibling No.						
Phys. Handicap						
Phys. Chron. disease						
Mental Disease						
Emotional Disturbance						
Mental Retardation						

PART III. S U B J E C T

1) TESTS GIVEN

Name of test						
Date of last testing						

2) IQ (as per last examination)

Test		
General		
Performance		
Verbal		

3) READING LEVEL

Test			
Grade level			
Score			

4) RELATION WITH PEERS

no information normal

withdrawn little interest in peers drifting

overdependent on peers scapegoat self-assertive

aggressive domineering likes to show off clown

isolated well accepted leader

....

....

5) OFFICIALLY STATED REASON FOR REFERRAL AND TRANSFER TO EH CLASS

....

....

....

6) SUMMARY OF LAST DIAGNOSIS

....

....

....

....

7) HISTORY OF SEVERE DISEASES AND/OR INJURIES

....

....

....

....

8) PHYSICAL HANDICAPS

Vision........................Hearing..........................

Speech........................Limbs............................

Brain.........................

9) NEUROLOGICAL FINDINGS

No examination   Examination negative   Examination positive

Abnormality	slight	medium	severe
E E G			
Reflexes			
Motor Coordination			
Perception			

Diagnosis of minimal organic brain damage   yes/no/no mention

10) SYMPTOMS (underline: one = slight, two = medium, three = severe)

Bedwetting   Tics   Thumb sucking   Stammering

Nail biting   Eating problems

Phobia (define)...

Compulsory behavior (define)..................................

Psychosomatic illness (define)................................

Epileptic fits.   grand mal.   petit mal.

11) ACTING OUT

Stealing   Destroys   Attacks persons

Verbal aggression   Tortures/mutilates animals

Disrupts class   Absconding from home/absconding from class

Loitering   Excessive masturbation   Sexual aggression

Homosexual activity   Other sexual aberrations

12) SEVERE SYMPTOMS

Sleeplessness Hallucinations Autistic behavior

Loss of reality control Suicide ideas/attempts

Depressions Anorexia Arson Dangerous aggression

* * * * * *

FILLED OUT BY...DATE.................

APPENDIX II

ATAXIAGRAMS OF EH STUDENTS WITH VARYING CLINICAL DIAGNOSIS

Legend:

Posture = Standing normally with eyes closed

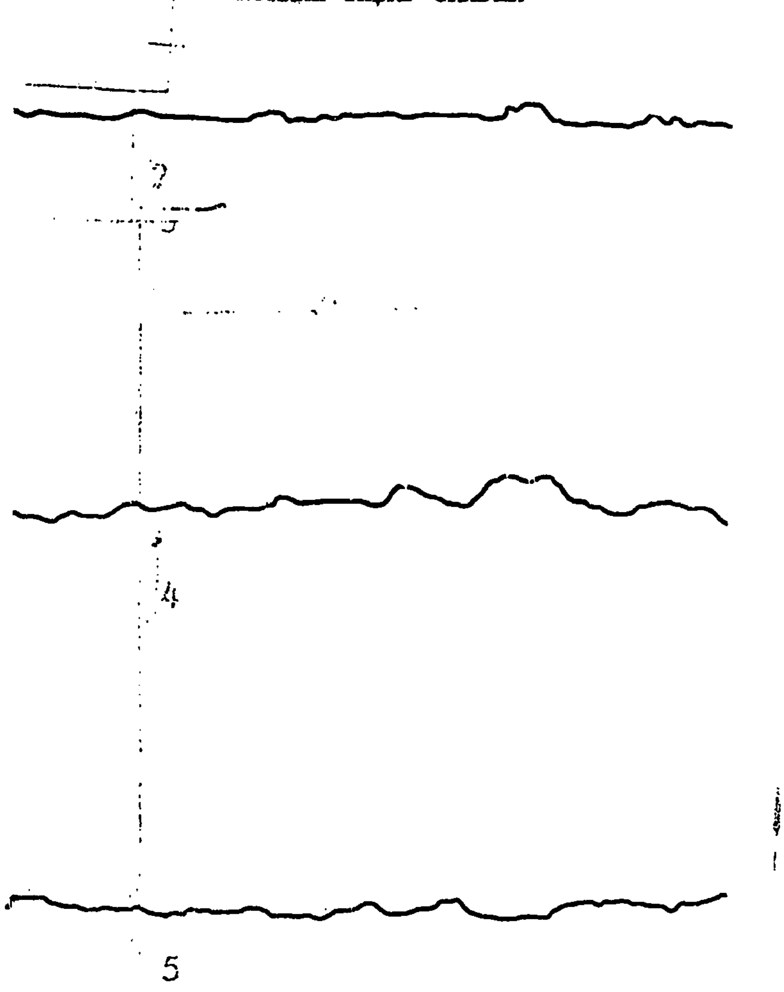
Experimental time = 20 seconds

Upper trace = left heel

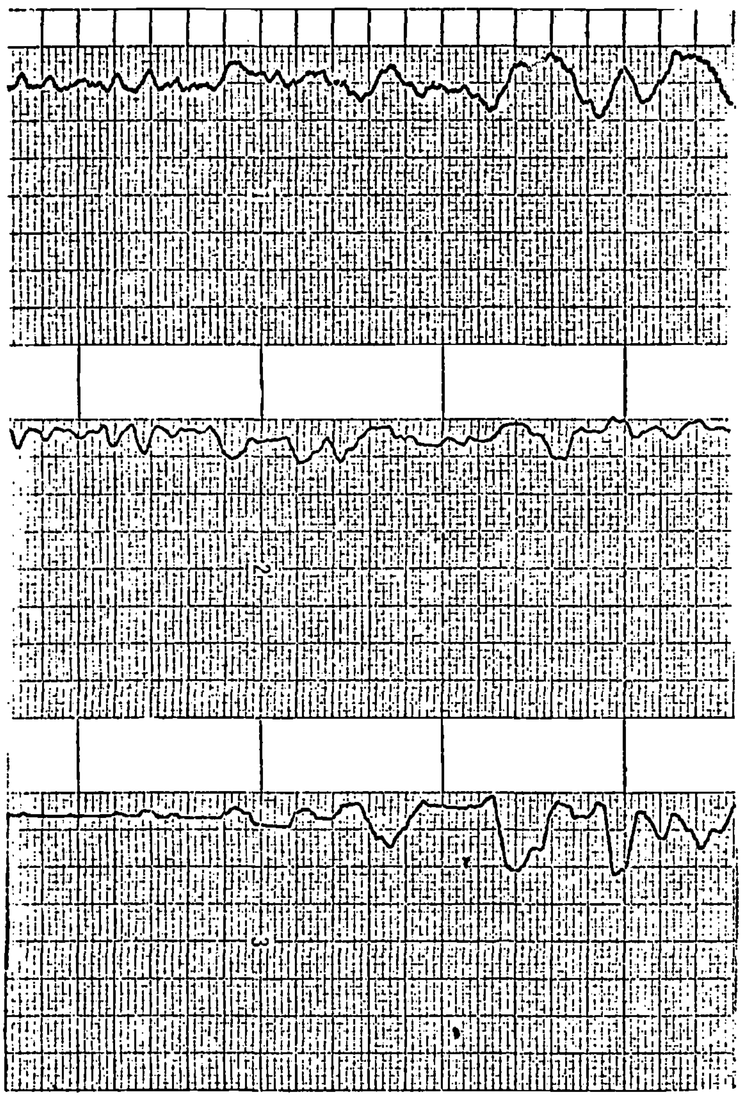
Middle trace = left toe

Lower trace = right heel

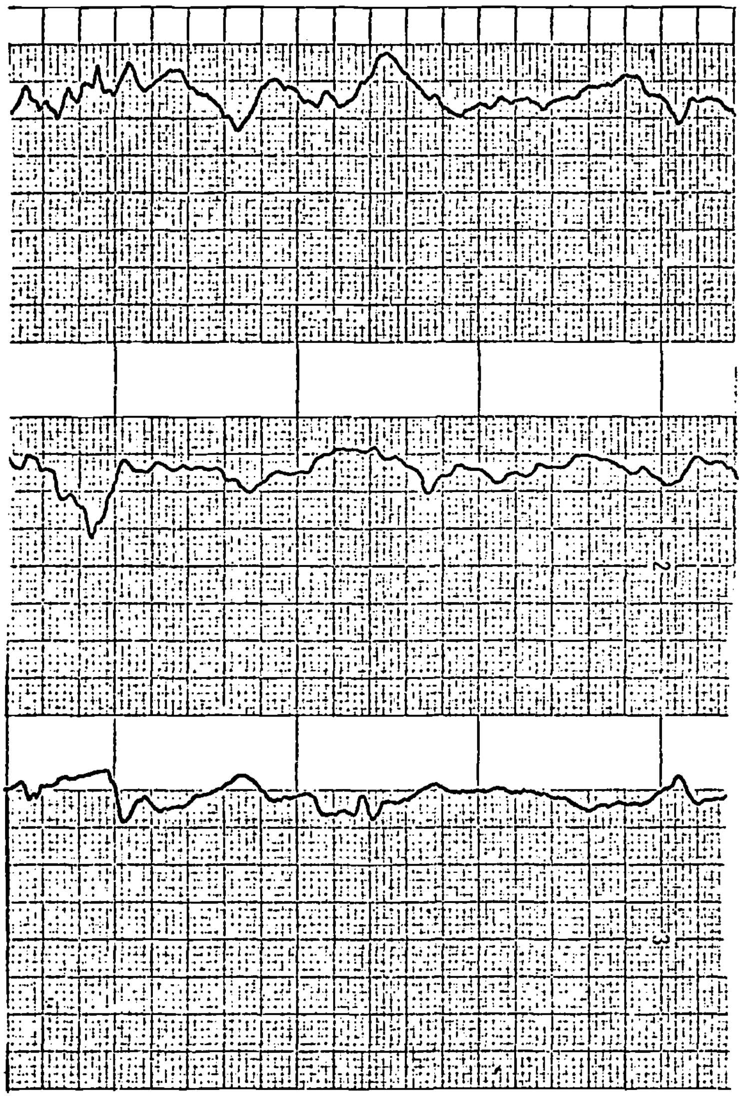
NORMAL THIRD GRADER



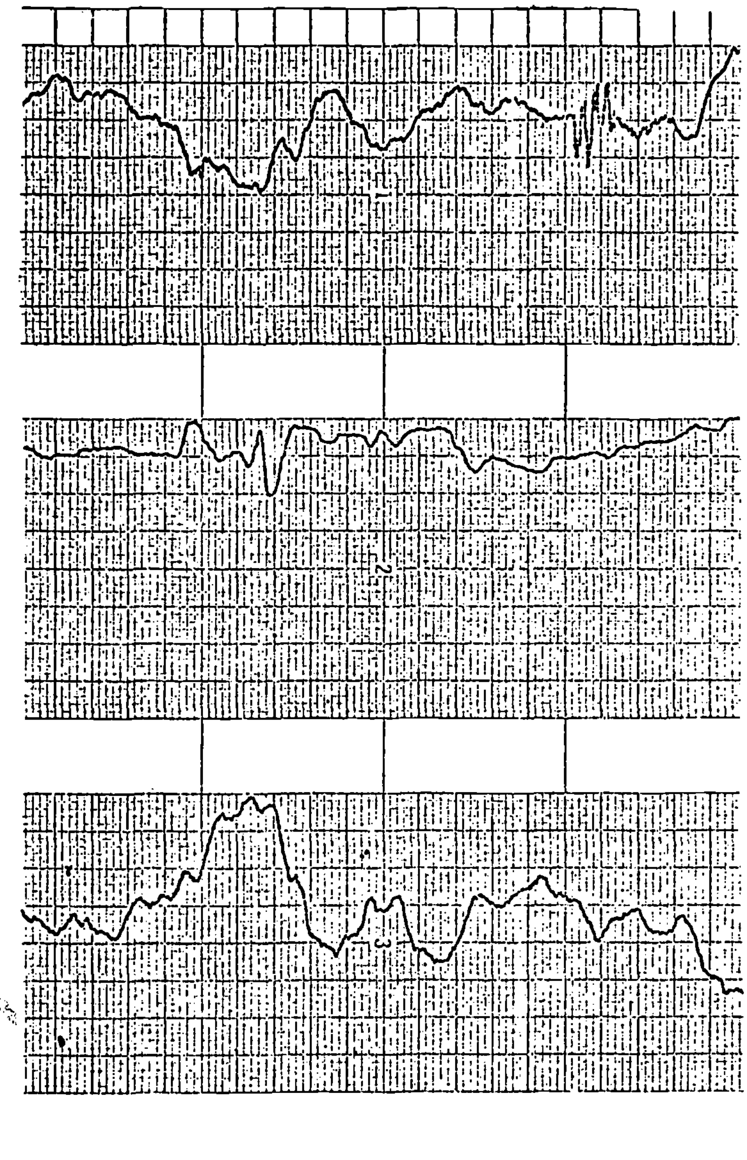
EPILEPSY



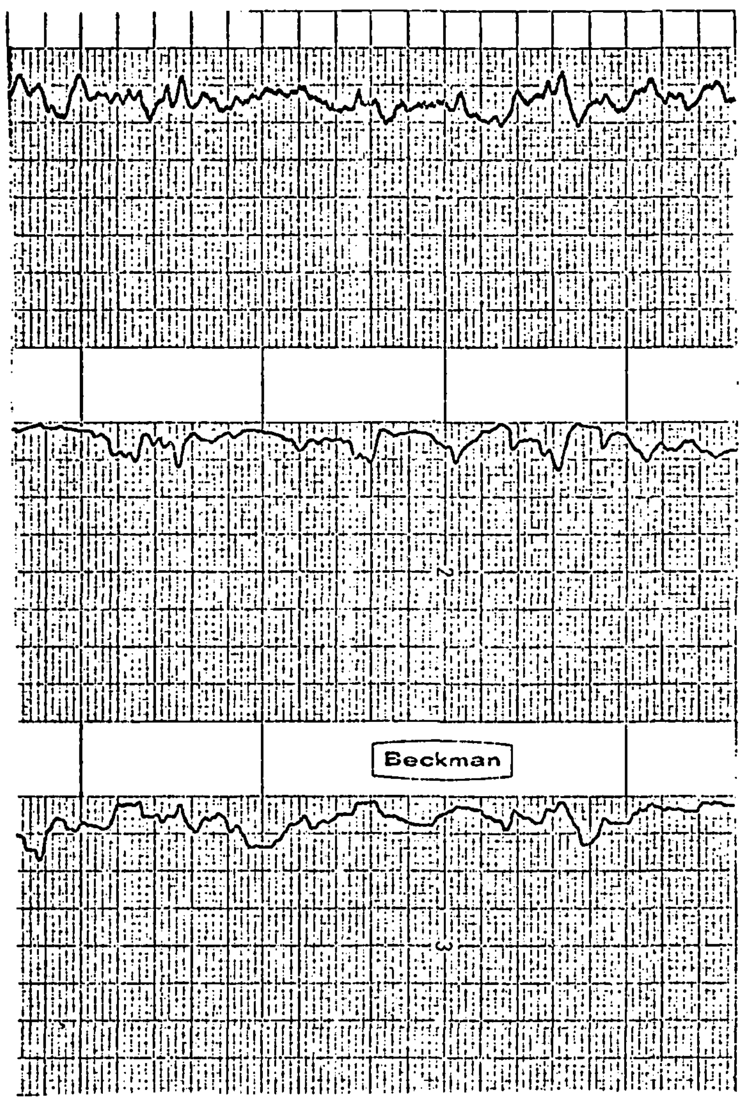
MINIMAL BRAIN DAMAGE



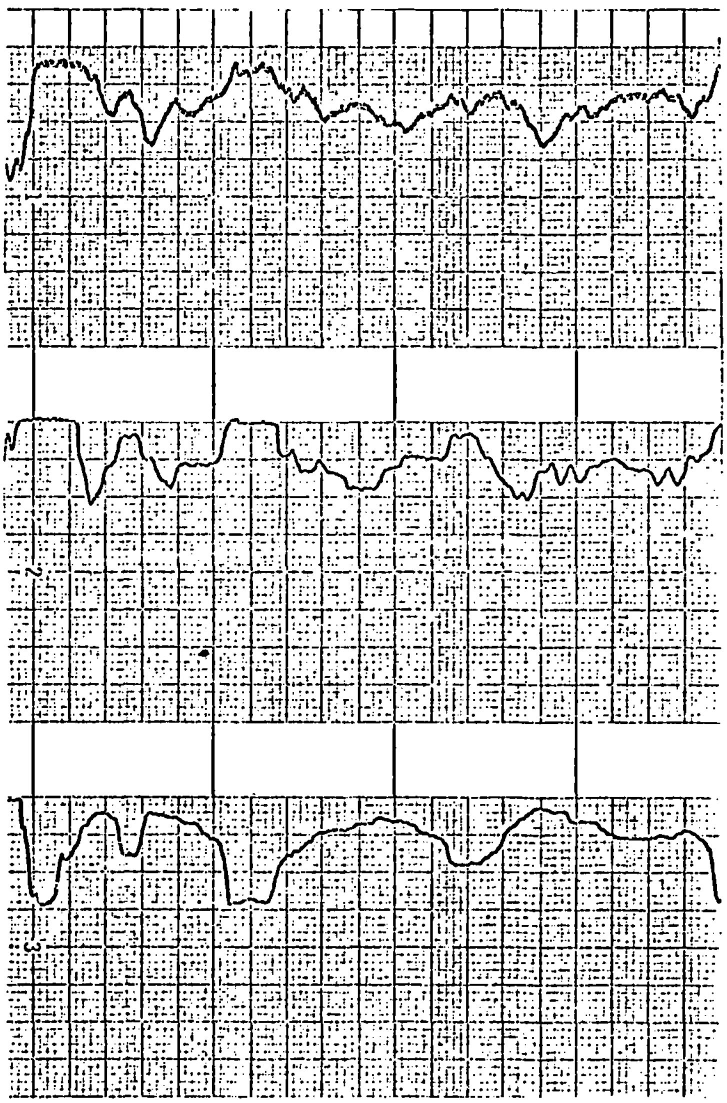
AUTISM



RICKETS



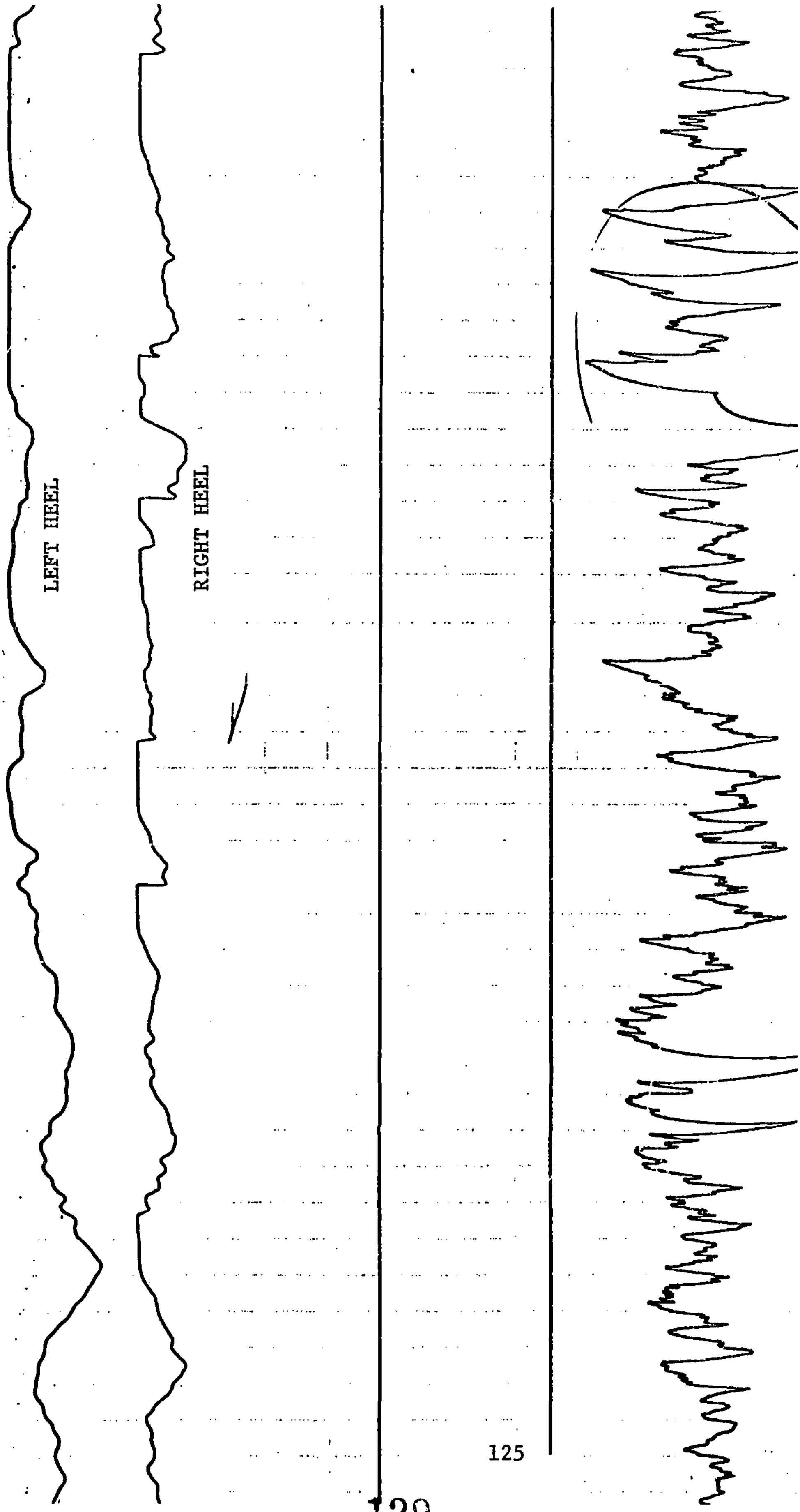
CEREBRAL PALSY



APPENDIX III

Simultaneous Electro-encephalographic
and Ataxiametric Record

Upper traces are records of left and right heel while standing heel to toe with eyes closed


LEFT HEEL
RIGHT HEEL